BUILDINGS TABLE OPTIONS REPORT

RESIDENTIAL SECTOR

FINAL

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Submitted by Marbek Resource Consultants

in association with
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LIST OF ACRONYMS

ACH	Air changes per hour
AMG	Analysis and Modelling Group
BAU	Business as Usual
CMHC	Canada Mortgage and Housing Corporation
COP	Coefficient of Performance
DHW	Domestic Hot Water
EE Products	Energy Efficient Products
ESCO	Energy Services Company
GHG	Greenhouse Gas
GST	Goods and Services Tax
HST	Harmonized Tax
HVAC	Heating, Ventilating and Air Conditioning
IRC	Institute for Research in Construction
LCC	Lifecycle costs
MNECB	Model National Energy Code for Buildings
MNECH	Model National Energy Code for Houses
NRCan	Natural Resources Canada
OTC	Outdoor Temperature Control
PST	Provincial Sales Tax
PV	Photovoltaic
PWGSC	Public Works and Government Services Canada

PART I: EXECUTIVE SUMMARY

INTRODUCTION

In December 1997, Canada and more than 150 counties negotiated the Kyoto Protocol, which sets greenhouse gas reduction targets for the post-2000 period. If ratified, the Protocol will commit Canada to reduce emissions of greenhouse gases to 6% below 1990 levels by the years 2008 to 2012.

Following the Kyoto Conference, a national process was initiated. Fifteen Issue Tables, including the Buildings Table, were established to provide expert input concerning greenhouse gas (GHG) reduction options. The Buildings Table's work led to the preparation of this Options Report.

The scope of this Options Report is emissions directly associated with new and existing low-rise residential buildings.[1] In principle this includes emissions associated with the construction, operation and eventual demolition of residential buildings. It also includes emissions associated with use of the appliances and other energy using equipment found in residential buildings. The Measures developed by the Table *do not* address related development issues such as urban planning, density, and zoning, which are being considered by other Issue Tables.

In this Options Paper, a number of terms are used to describe the activities and outputs of the Buildings Table. Key among these are the following:

- **Action:** An "action" is a specific step taken to reduce greenhouse gas emissions. For instance, roof insulation or window replacement would be considered actions.

- **Measure:** A "Measure" is a specific program initiative that will stimulate one or more actions. For instance, a retrofit assistance program would be considered a Measure.

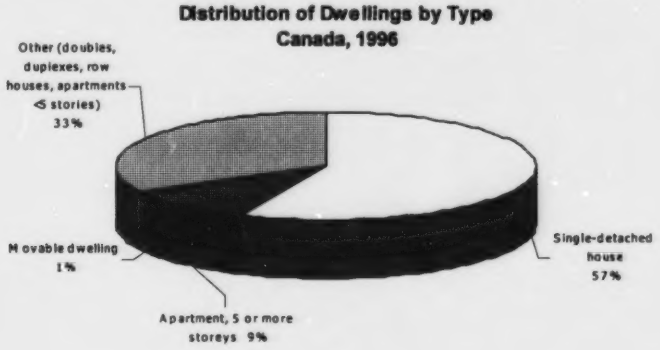
- **Options Package:** An "Options Package" is an integrated set of several Measures designed to serve as a possible climate change program for the sector.

OVERVIEW OF THE SECTOR

As of 1996, there were a total of about 10.8 million occupied dwellings in the residential stock in Canada. As illustrated in the figure below, at the national level single detached dwellings continue to be the major

[1] Mid- and hi-rise residential buildings are addressed in the *Buildings Table Options Report -- Commercial Sector.* Separate consideration of mid- and hi- rise residential recognizes that GHG reduction opportunities/needs in this segment are different from those in the low-rise segment, and have more in common with the commercial sector (or certain segments of it).

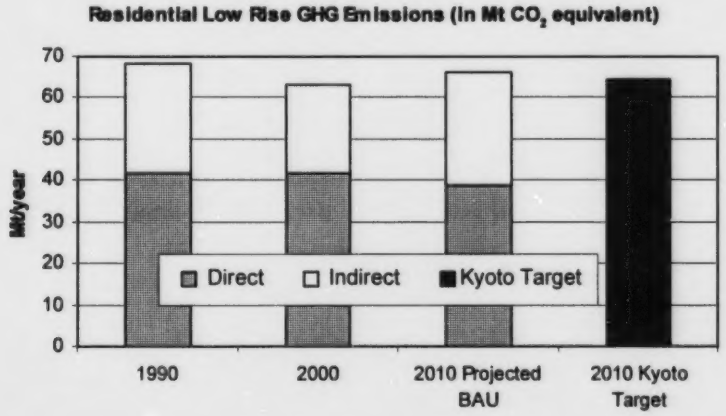
dwelling type, with about 57% of the total. Semi-detached houses, row houses, duplexes, and apartments less than 5 storeys make up about 33% of the stock.


Distribution of Dwellings by Type
Canada, 1996
Other (doubles, duplexes, row houses, apartments <5 stories) 33%
Movable dwelling 1%
Apartment, 5 or more storeys 9%
Single-detached house 57%

In 1995, residential sector GHG emissions represented 12% of all of Canada's GHG emissions. These emissions were associated primarily with space heating (60%), water heating (22%), appliances (13%), lighting (4%), and space cooling (<1%).

GHG emissions from low-rise residential energy use are presented in the next figure, both direct (i.e. emissions on-site) and indirect (associated with electricity use, with emissions at the point of generation). Total emissions were estimated to be 68.4 Mt CO_2 equivalent in 1990. Under the business-as-usual scenario, emissions are projected to be 66.2 Mt in 2010, 3.2% below 1990 levels. Meeting the Kyoto target of 6% reduction implies the need for measures that yield a minimum GHG reduction of approximately 2 Mt compared to the business-as-usual scenario.

In these projections, direct emissions in 2010 are 7% below 1990 levels, whereas indirect emissions are 2.6% above. These differing trends arise primarily because electricity use (indirect emissions) is expected to grow in the residential sector, driven by increasing penetration and use of electrical equipment and



appliances. Conversely, for the end uses most associated with direct emissions, continuing efficiency improvements are anticipated (e.g. increasing penetration of efficient furnaces).

DESCRIPTION AND ANALYSIS OF THE MEASURES

The table below presents summary descriptions, national greenhouse gas impact, and cost per tonne of GHG reduction, for the 15 primary residential Measures under consideration by the Buildings Table. (An additional Measure, Building Permit Feebates, was referred to the Municipalities Table for consideration, and as such is not presented here.)

Measure Name and Type	Description of Residential Measure	GHG reduction in 2010 (kT/yr)	Cost per tonne ($/tonne)
R-3: National Energy Efficient Housing Renovation and Retrofit Program **Type: Suasion/ incentive**	This Measure is designed as a comprehensive and integrated initiative to encourage consumers to upgrade the efficiency of existing homes. It includes: incentives to retrofit/renovate (tax breaks such as removal of GST, PST, HST, and/or accelerated depreciation of costs in rental housing); access to financing; home energy audits and labelling (EnerGuide for Houses); renovator training/certification; a retail element including sales force training; and involvement of community based delivery agents (e.g., Green Communities).	3144	$40
AE-1: National Standards Program for Equipment and Appliances **Type: Regulatory**	This Measure involves minimum efficiency standards for a range of products, with new standards introduced in 2004. Products to be addressed would include HVAC equipment (including HRVs); major appliances; domestic water heaters; lighting; windows and doors; motors; and gas fireplaces. EnerGuide labelling would also be included for most products.	1999	$11
AE-5: Premium Energy Performance Labelling Program for Equipment and Appliances **Type: Suasion**	This Measure involves a Premium Energy Performance label for the top performers within each product category (say top 15-20%, but varying by category). Products to be addressed by this measure would include: HVAC equipment (including HRVs); major appliances; domestic water heaters; lighting; windows and doors; motors; and gas fireplaces.	367	$17
AE-8: Equipment Leasing Facilitation Program **Type: Suasion**	This Measure would facilitate uptake of new technology through leasing arrangements, removing risk factors for owners. It depends on private sector initiative involving both the manufacturers of the equipment in question, and financial and leasing companies. To encourage development of an industry-wide initiative, leadership by industry associations will be essential.	300	$12

Measure Name and Type	Description of Residential Measure	GHG reduction in 2010 (kT/yr)	Cost per tonne ($/tonne)
R-7V: EnerGuide for Houses Program - Voluntary **Type: Suasion**	This Measure is an extension and expansion of existing programs to promote purchase of energy efficient new and existing homes. Households that wish to participate would receive a home energy audit and, based on the results of the audit and any retrofit actions undertaken, these houses would be rated/labelled with respect to energy efficiency. Renewable energy measures in the home would also be reflected in the rating. Note: A voluntary EnerGuide for Houses is also incorporated in Measure R-3.	219	$35
R-6B: R-2000 for Existing Dwellings Renovation Program **Type: Suasion/ incentive**	This market leadership program is similar in concept to the R-2000 program for new housing. Specifically, the program will encourage and support high level retrofit of a small portion of the existing housing stock across the country. It will incorporate key features of the established R-2000 program. This will likely include: development of an R-2000 retrofit guideline incorporating high levels of energy efficiency and advanced retrofit techniques; training and certification of R-2000 retrofit contractors; independent evaluation and certification of R-2000 retrofits; and strong marketing of the program and its benefits.	201	$44
R-5A: Strengthened R-2000 Program **Type: Suasion**	This Measure involves strengthening the R-2000 program. The target is to shift the market so that certified R-2000 homes achieve a penetration rate of 10% of new construction (compared to a business-as-usual penetration of 3%). This will require more resources for marketing, access to preferred mortgage rates (in cooperation with the banking community), expanded builder training and certification, and streamlined requirements and certification process. This expansion will require strong commitment from governments and industry.	179	$21
R-1A: Assisted Housing Program **Type: Suasion**	This is a Measure to undertake energy efficiency improvements in the social housing/assisted housing stock. The financing is expected to involve funding from provincial or federal sources, loans from provincial or municipal revolving funds, leveraged involvement of private sector financial institutions, and/or other alternative financing approaches.	178	$50
R-1B: Low Income Housing Program **Type: Suasion/ incentive**	This Measure is designed to provide financing and assistance for energy efficiency improvements in the low income owner-occupied stock (retrofit, weatherization, heating systems, etc.). Grants of up to $10,000 (notional) would piggyback on the RRAP program. Additional financing would involve loans from provincial or municipal revolving funds, leveraged involvement of private sector financial institutions, and/or other alternative financing approaches. This targeted Measure would be supported by the several elements of Measure R-3.	177	$28

Measure Name and Type	Description of Residential Measure	GHG reduction in 2010 (kT/yr)	Cost per tonne ($/tonne)
R-6A: Housing Energy Technology Demonstration Program **Type: Suasion**	This is an enabling measure intended to generate long-term improvements in energy efficiency in housing. Elements would include: demonstration of new design approaches; demonstration of "market-ready" technology (advanced integrated mechanical systems, renewable energy technologies, home automation technology, etc.); and extension activities relating to the demonstrations (preparation of guidelines, dissemination of information, workshops, etc.).	157	$34
AE-4: Technology Commercializa-tion Program (Includes Renewable Technologies) **Type: Suasion**	This Measure would promote technologies such as integrated systems/heat pumps; solar and instantaneous domestic hot water heating systems; advanced lighting technologies; ground source heat pumps; and other proven technology that has not yet developed a significant market in Canada.	157	$34
R-10: Residential Retrofit Guidelines and Installation Standards **Type: Suasion**	This is an enabling Measure designed to improve the energy efficiency of renovations and equipment installations. The guidelines and standards would support other proposed Measures, and adherence to the guidelines/standards would be encouraged or required in these Measures. The guidelines/standards would also be available for use/adoption by, for instance, individual companies, industry associations, municipalities, and other agencies involved in retrofit.	126	$38
R-4A: Adoption of More Stringent MNECH by Provinces **Type: Regulatory**	This Measure sets in place provincial minimum energy efficiency regulations for new housing and major additions, based on a revised and more stringent Model National Building Code for Houses (MNECH). In five provinces, this would involve replacement/ harmonization of existing codes with the more stringent MNECH; in the other provinces, it would involve adoption of an energy code for the first time.	615	$14
R-7M: EnerGuide for Houses Program - Mandatory **Type: Regulatory**	This Measure is a mandatory variant of the EnerGuide for Houses program described above (Measure R-7V). As with the voluntary alternative, participants would receive a home energy audit and, based on the results of the audit and any retrofit actions undertaken, these houses would be rated/ labelled with respect to energy efficiency. In the mandatory alternative, home owners and builders would be required to obtain the EnerGuide label prior to the sale of any home.	564	$31

Measure Name and Type	Description of Residential Measure	GHG reduction in 2010 (kT/yr)	Cost per tonne ($/tonne)
AE-6: Reduced Sales Tax to Encourage Purchase of EE Products in New Construction **Type: Incentive**	This Measure would remove the GST/PST/HST from energy-saving equipment and products used in new construction (or alternatively provide other equivalent tax reduction). A primary focus would be on appliances and equipment addressed by Measure AE-5 (Premium Energy Performance Labelling Program for Equipment and Appliances), but insulation and renewable energy technologies would also be included in the program. Eligibility would be restricted to new construction achieving specified levels of energy performance. Note: Similar tax reductions are proposed for existing housing through Measure R-3.	126	$28

Based on the current NRCan business-as-usual scenario, the suasion Measures alone would reduce emissions in 2010 to a level approaching 6% below 1990 levels. Similarly, either Measure AE-1 or Measure R-3 would reduce emissions to 6% or more below 1990. The impact of these Residential Measures during the period following 2010, when emissions in the business-as-usual scenario increase significantly, has not been modelled.

The costs per tonne of GHG reduction are positive in all cases. The lowest costs per tonne are generally associated with the equipment and appliance measures, and with new housing. Those Measures that address renovation and retrofit of existing housing are the most expensive (but also address the areas with the greatest GHG reduction potential).

In addition to the analysis of greenhouse gas emission reductions and costs, a preliminary review of the economic, social, environmental, and health impacts of each Measure was undertaken. While each Measure is unique, in most cases the assessment identified more positive than negative impacts. Where there are specific issues of potential concern associated with a given Measure, these are identified in Appendix B of the main report.

One area that received particular attention was the potential impact of the Measures on affordability of housing. This issue was addressed in a supplementary study supported by CMHC. This study concluded that the proposed regulatory Measures (R-4A and AE-1) would reduce housing affordability. This conclusion was not supported by some members of the Buildings Table. Further discussion is provided in Appendix B of the main report.

DESCRIPTION AND ANALYSIS OF THE OPTIONS PACKAGES

Based on the analysis of the individual Measures, the Table developed two Options Packages. Each package consists of a set of Measures that can be viewed as an integrated climate change program for the sector. The Options Packages provide broad coverage of new and existing housing, and of equipment and

appliances. The majority of Measures fall into the suasion category, but each of the packages also includes incentive and regulatory Measures. Dissenting views with respect to the Options Packages are presented in the Recommendations section of this Executive Summary.

Package A includes:

- All of the suasion-type Measures (e.g. R-5A Strengthened R-2000 Program)
- AE-1 National Standards Program for Equipment and Appliances
- Two broad retrofit Measures: R-3 National Energy Efficient Housing Renovation and Retrofit Program, and R-6B R-2000 for Existing Dwellings Renovation Program
- Two additional retrofit Measures targeted at specific segments of the existing housing market: R-1A Assisted Housing Program, and R-1B Low Income Housing Program.

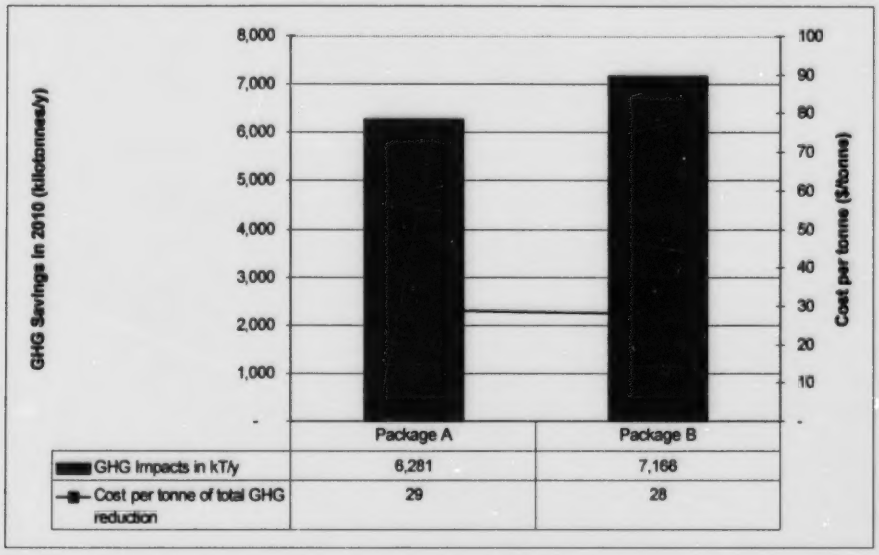
Package B includes:

- All of the Measures from Package A
- An additional incentive Measure: AE-6 Reduced Sales Taxes to Encourage Purchase of EE Products in New Construction
- Two regulatory Measures: R-4A Adoption of More Stringent MNECH by Provinces, and R-7M EnerGuide for Houses Program - Mandatory.

The two residential Options Packages are summarized in the table below.

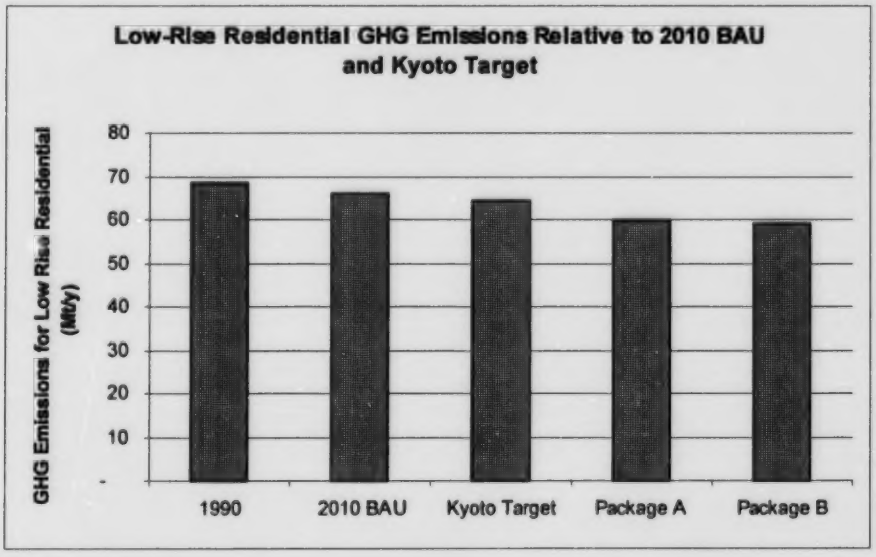
Package A	R-3 National Energy Efficient Housing Renovation and Retrofit Program AE-1 National Standards Program for Equipment & Appliances AE-5 Premium Energy Performance Labelling Program for Equipment and Appliances AE-8 Equipment Leasing Facilitation Program R-7V EnerGuide for Houses Program - Voluntary R-6B R-2000 for Existing Dwellings Renovation Program R-5A Strengthened R-2000 Program R-1A Assisted Housing Program R-1B Low Income Housing Program R-6A Housing Energy Technology Demonstration Program AE-4 Technology Commercialization Program R-10 Residential Retrofit Guidelines and Installation Standards
Package B	Package A plus: R-4A Adoption of More Stringent MNECH by Provinces R-7M EnerGuide for Houses Program– Mandatory AE-6 Reduced Sales Tax to Encourage Purchase of EE Products in New Construction

The two Options Packages were modelled for GHG impact and cost per tonne of GHG reduction, based on the modelling results for the individual Measures. However, due to the interactive effects between Measures within an Options Package, the individual impacts were derated as a function of overlapping penetration rates. The results for each Options Package are presented in the figure below.



Comparison of GHG Impacts and Cost per Tonne for Residential Options Packages

Both Packages surpass the Kyoto GHG reduction target of 6% below 1990 levels, as shown in the next figure. Specifically, Package A reduces emissions to about 12% below 1990 levels, and Package B to nearly 14% below 1990.



RECOMMENDATIONS

The Buildings Table offers the following majority recommendations with respect to the identified residential Options Packages:

Recommendation:	**The Buildings Table recommends Options Package A as the minimum greenhouse gas reduction package for the low rise residential sector.**
Dissenting views:	The following table members have requested that their dissenting views be recorded: John Haysom (National Research Council), who does not support inclusion of R-3 (National Energy Efficient Housing Renovation and Retrofit Program) in the minimum Options Package; and the Canadian Home Builders' Association, who believe that Measures R-3 and AE-1 (National Standards Program for Equipment and Appliances) are problematic and require further development and analysis to enable realistic evaluation.
Recommendation:	**The Buildings Table did not reach agreement on a majority recommendation with respect to Options Package B.**
Commentary:	The additional Measures in Options Package B are supported by some members, but strongly opposed by others. All members agree that further development and analysis is required.

The Buildings Table offers the following additional recommendations relating to the implementation of the Options Packages:

Recommendation:	**Initiation of selected Measures within Options Package A should begin as soon as possible. The development process for the remaining Measures should also be initiated in the near term.**
Commentary:	The "easy" Measures in Options Package A provide an early opportunity to begin to reduce greenhouse gas emissions. In addition, several Measures in Options Package A provide a foundation for more effective implementation of other Measures. As such, early implementation is desirable. The implementation process for any new or expanded initiative is time consuming. To ensure timely launch of the proposed Measures, the developmental process should begin early.
Recommendation:	**Although some Measures within Options Package A will be implemented before others, the Package should nonetheless be considered as a comprehensive program of initiatives. Any decision to select only a subset of the Package for implementation should be based on careful consideration of the linkages and complementarity between Measures.**

Commentary:	The Measures proposed provide broad coverage of the residential sector, and encompass a range of program types. The concepts underlying many of the Measures depend on, and support, several of the other Measures. These syneregies will be lost if changes to the Packages are implemented without careful consideration.
Recommendation:	**To provide a valid analytical support capacity and ensure minimal program monitoring requirements are met, it is recommended that appropriate data gathering and development activities be included as part of any Climate Change strategy and activity.**
Commentary:	Effective greenhouse gas reduction will require effective monitoring of results achieved, and analytical capacity to interpret and make use of the monitoring data.

ADDITIONAL WORK NEEDED

The analysis presented in the Options Paper is intended to provide initial information to assist in the screening and selection of broad options. As the Measures and Options Packages are developed further, additional research will be required, particularly at the detailed design stage. This would include, for instance, more detailed costing, further assessment of costs and benefits, review of program design options, and dialogue with partners and other stakeholders.

Other issues of importance include the question of linkages at several levels: integration between residential and commercial sector Measures developed by the Buildings Table; linkage to initiatives developed by other Issue Tables; and co-ordination of Canada's approach to residential GHG emissions with approaches adopted elsewhere.

The Measures and analysis presented here are focussed on the Kyoto targets for the years 2008-2012. In the future, Measures to address a longer time frame need also to be considered, because the residential sector business-as-usual scenario shows greenhouse gas emissions growing significantly in the period after 2010.

PART II: OVERVIEW OF TABLE'S WORK

1. INTRODUCTION

In December 1997, Canada and more than 150 counties negotiated the Kyoto Protocol, which sets greenhouse gas reduction targets for the post-2000 period. If ratified, the Protocol will commit Canada to reduce emissions of greenhouse gases to 6% below 1990 levels by the years 2008 to 2012.

Following the Kyoto Conference, a national process was initiated. Fifteen Issue Tables, including the Buildings Table, were established to provide expert input concerning greenhouse gas (GHG) reduction options. The options developed by the Tables will become the basis for a National Climate Change Strategy that will guide Canada's efforts to meet the Kyoto commitments.

The mandate of the Buildings Table is to develop, analyse, and propose options to reduce greenhouse gas emissions associated with commercial, institutional and residential buildings. The Table draws its members from a wide range of backgrounds including government, the private sector, and not-for-profit organizations. The members of the Table are listed in Appendix D.

The Buildings Table's work led to the preparation of this Options Report. ***The Report presents a series of GHG reduction measures, their impacts, and the Table's assessment of them.***

The scope of this Options Report is new and existing low-rise residential buildings. Mid- and hi-rise residential buildings (greater than five storeys) are addressed in the separate *Buildings Table Options Report -- Commercial Sector.*[2]

[2] Prepared by Bay Consultants for the Buildings Table. Separate consideration of mid- and hi- rise residential recognizes that GHG reduction opportunities/needs in this segment are different from those in the low-rise segment, and have more in common with the commercial sector (or certain segments of it). For information purposes, the summaries of GHG impacts presented later in this report also include mid- to high-rise residential data.

2. DEFINITIONS

In this Options Paper, a number of important terms are used to describe the activities and outputs of the Buildings Table. Key among these are the following:

- **Action:** An "action" is a specific step taken to reduce greenhouse gas emissions. For instance, roof insulation or window replacement would be considered actions.

- **Measure:** A "Measure" is a specific program initiative that will stimulate one or more actions. For instance, a retrofit assistance program would be considered a Measure.

- **Options Package:** An "Options Package" is an integrated set of several Measures designed to serve as a possible climate change program for the sector.

3. ANALYTICAL APPROACH

3.1 OVERVIEW

Consistent with the approach taken by other Tables, the Buildings Table began its residential sector work by commissioning the *Residential Sector Climate Change Foundation Paper.*[3]

Based on this background information, the Table issued a contract for the analysis of greenhouse gas impact, and lifecycle cost, of a selected set of ***actions*** believed to have potential to reduce GHG emissions. The analysis adopted a cost curve approach, in accordance with guidelines provided by the Climate Change Secretariat. Details are provided in the report *Commercial/ Institutional and Residential Sector Action/Opportunity Cost Curves.*[4]

In parallel with this analysis, the Table itself developed a list of 59 candidate ***Measures.***[5] In April 1999, the Buildings Table met to further consider the proposed Measures, and to incorporate the findings of the cost curves study into the definition of the Measures. This yielded a reduced list of more specifically defined Measures.

Next, this list of Measures was analyzed according to the Climate Change Secretariat guidelines. Specifically, the GHG impact and life-cycle cost of the Measures were modelled using a methodology similar to that used for the actions. In addition, the environmental, economic and social impacts were reviewed for each Measure.

The Buildings Table met in June 1999 to consider the results of the Measures analysis, and to identify ***Options Packages***. Each of the Options Packages was subsequently analysed in accordance with Climate Change Secretariat guidelines. The Table met again in July 1999, to refine the Measures and Packages, and to develop recommendations.

The overall results of this process are reflected in this *Options Report.* Additional detail concerning the analysis of the Measures and Options Packages is provided in the report *Commercial/Institutional and Residential Sector Measures Development and Analysis.*[6]

3.2 KEY AREAS OF FOCUS

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[3] Sheltair Scientific Limited, in association with Marbek Resource Consultants and SAR Engineering, December 1998.

[4] Marbek Resource Consultants, in association with Sheltair Scientific, and SAR Engineering (April 1999).

[5] *Master List of Measures for Further Analysis*, Buildings Table, April 1999.

[6] Marbek Resource Consultants, in association with Sheltair Scientific, and SAR Engineering (August 1999).

In the development of measures, the Table has focussed on emissions directly associated with the residential sector. In principle this includes emissions associated with the construction, operation and eventual demolition of residential buildings. It also includes emissions associated with use of the appliances and other energy using equipment found in residential buildings. The Measures developed by the Table *do not* address related development issues such as urban planning, density, and zoning, which are being considered by other Issue Tables. Similarly, the Buildings Table Measures do not directly address issues such as municipal services and electricity supply, which are also being considered by other Tables.

Although the construction (pre-occupancy) and demolition (post-occupancy) stages of the life cycle of residential buildings are within the mandate of the Buildings Table, the *Residential Sector Climate Change Foundation Paper* commissioned by the Table[7] found that the occupancy stage accounted for over 95% of total life cycle GHG emissions in three sample new houses. ***Because of the dominance of the occupancy stage in total emissions associated with residential buildings, the Table has focussed all proposed Measures in this area.***

3.3 METHODOLOGICAL ISSUES

The key methodological issues arising in the modelling of the actions, Measures, and Options Packages are outlined in the reports cited previously. In brief, some of the issues are as follows:

Selection of actions

- There is a wide range of actions that can be taken to reduce GHG emissions in the residential sector. It is not practically possible to model all of these actions. Consequently, the actions modelled within a particular Measure are judged to be the most important, but may not include all actions that could in principle be stimulated by the Measure. In practice, this means that the actual investment associated with the Measure may be distributed across a wider range of actions. Unless it is assumed that the additional actions are associated with additional investment (rather than simply redistribution), the modelling results can be accepted as representative of the likely impact of the Measure, even though some candidate actions have not been included.

- The GHG impact and cost per tonne of GHG reduction are both influenced significantly by the detailed definition of the actions that make up a Measure. For instance, the decision about what insulation level is to be provided by an action will affect both the GHG impact and the cost per tonne (as insulation levels increase, incremental GHG impact and cost-effectiveness both decline). Moreover, in defining an action, it is difficult to anticipate the impact of technological development over the period to 2010.

Assumptions and data

[7] Sheltair, Marbek, and SAR, *op. cit.*

- The methodology employed requires the definition of a "business-as-usual" scenario that projects GHG emissions to the year 2010, assuming the absence of new measures to reduce emissions. Such a scenario depends on both credible baseline data and a wide range of assumptions concerning changes in the housing stock of the future. Establishing an agreed upon business-as-usual scenario has been a challenging exercise, requiring significant effort to reconcile differing projections.

- There are significant gaps or weaknesses in the data required for some aspects of the analysis and modelling. For instance, a particular challenge arises with respect to the modelling of Measures. The penetration rate that will be achieved for each of the actions stimulated by a Measure is an extremely important variable, and one for which there is little relevant empirical data on which to base assumptions. Similarly, the costs of a Measure (administrative costs, and costs of incentives if applicable) are not only difficult to estimate in many cases, but also interact with and influence the expected penetration rates.

- Some Measures, such as the Premium Energy Performance Labelling Program and R-2000 program, have both a direct effect (purchase of Premium Energy Performance equipment and R-2000 houses), and an indirect effect (influencing efficiency in the larger marketplace). While the direct effects can be modelled in a conventional manner, the indirect effects pose additional challenges. For purposes of this analysis, the indirect effect has been modelled by increasing penetration rates above what would have been associated with the direct impacts alone.

- The analysis of the costs and savings is based on a number of assumptions that are believed to be conservative. For instance, the costs of retrofit actions assume installation by a contractor. In fact, it can be expected that some portion of this work will be done on a do-it-yourself basis, at lower cost. As another example, the discount rate specified by the Climate Change Secretariat (10%) will produce what can be considered to be conservative results with respect to energy cost savings.

Analytical considerations

- For some Measures, the cost per tonne of GHG reduction appears high, relative to previous estimates for individual actions. Since this earlier analysis of cost per tonne was undertaken, significant refinements to the NRCan business-as-usual scenario have been made, including adjustments to the equipment stock data. In particular, the baseline now assumes greater penetration of higher efficiency heating equipment, compared to the assumptions adopted in the previous modelling of actions. As a result, the energy savings from upgrading to high efficiency equipment are much lower, resulting in greater life cycle costs, and higher cost per tonne of GHG reduction.

- The GHG impact and life-cycle cost of any Measure that involves electricity will be heavily influenced by assumptions concerning electrical generation. In other words, a kWh of electricity

saved will have different GHG implications if the avoided generation was based on natural gas, compared to avoided generation based on coal, hydro, or any other source.

In the business-as-usual scenario, emissions are based on the actual mix of electrical generation expected in 2010. Electricity savings, on the other hand, have been calculated based on marginal electricity, as per the guidelines from the Climate Change Secretariat (AMG). Specifically, the analysis of Measures presented in Appendix B assumes combined cycle natural gas electrical generation at 50% efficiency for all provinces.

For information purposes, Part V of this *Options Report* also presents a summary chart based on a second marginal fuel scenario ("regional marginal"), which assumes a different marginal fuel for each province. Emission factors for this scenario are as specified by the Climate Change Secretariat (AMG).

- The Measures presented in Part IV and Appendix B of this document have in the first instance been analysed on a "stand alone" basis. It is important to recognize that the impacts of these Measures ***cannot*** simply be added together. While certain Measures are entirely independent, in other cases there is overlap because different Measures target the same actions. This does not necessarily imply that the Measures are redundant, but it does mean that the total impact of the Measures will be less than the sum of the individual impacts.

  As a result, the analysis of Options Packages, which consist of several Measures, requires a determination of the degree of overlap among the Measures. For those Measures that are primarily enabling in nature, the overlap has been examined from the perspective of the Measure as a whole. However, for the major Measures, each of which encompasses numerous actions, the degree of overlap has been determined at the level of the actions. Based on this determination, the Measures have been re-modelled to provide a basis for integration into the specific Options Package.

- The cost per tonne of GHG reduction can be calculated and presented in different ways. In the earlier work of the Buildings Table, this data was presented as cost per tonne of GHG reduction ***in 2010***. In this final version of the *Options Report*, the data is presented as cost per tonne of ***total*** GHG reduction (i.e. total reduction over the life of the various actions stimulated by the Measure). This alternative presentation is based on guidance from the Climate Change Secretariat (AMG), and does not involve any change in the underlying data. Note that the cost elements considered in the cost per tonne calculation include the capital cost of the actions taken as a result of a Measure, and the resulting energy cost savings. Other factors, such as possible impact on resale value of the home, are excluded from this calculation.

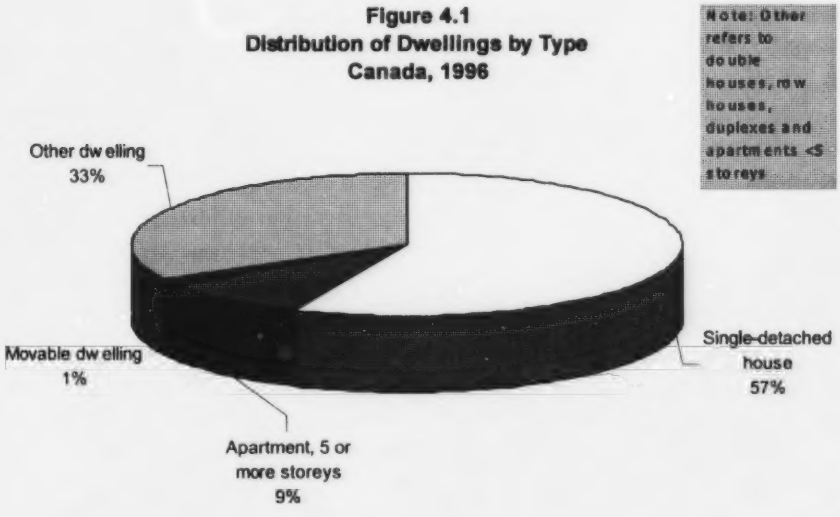
PART III: BACKGROUND INFORMATION ON THE RESIDENTIAL SECTOR

4. OVERVIEW OF THE SECTOR[8]

4.1 CURRENT STOCK

As of 1996, there were a total of about 10.8 million occupied dwellings in the residential stock in Canada. At the national level, single detached dwellings continue to be the major dwelling type, with about 57% of the total. Semi-detached houses, row houses, duplexes, and apartments less than 5 storeys make up about 33% of the stock. Only 9% of units are in apartment buildings 5 storeys and over. This 9% is clustered in certain large cities in Ontario, Quebec, and British Columbia. Figures 4.1[9] and 4.2 present the distribution of dwellings nationally and by province, respectively.

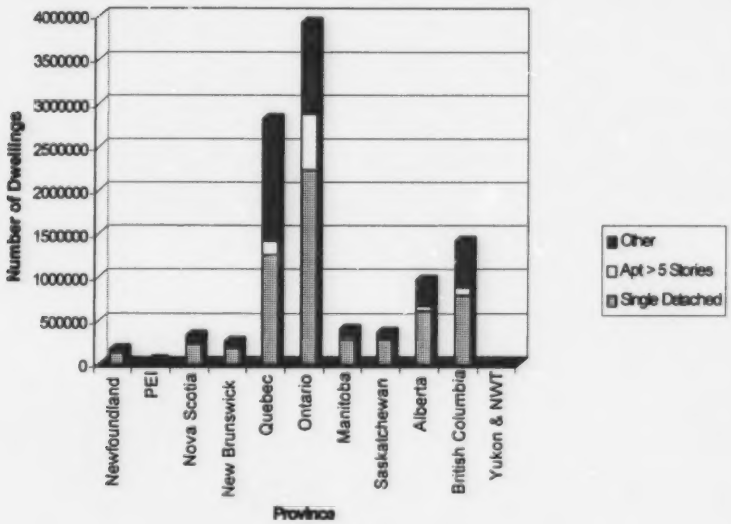
Figure 4.1
Distribution of Dwellings by Type
Canada, 1996


Note: Other refers to double houses, row houses, duplexes and apartments <5 storeys
Other dwelling 33%
Movable dwelling 1%
Apartment, 5 or more storeys 9%
Single-detached house 57%

[8] Unless otherwise specified, information in this section is taken from the *Residential Sector Foundation Paper*, prepared by Sheltair, Marbek, and SAR (*op.cit.*)

[9] Statistics Canada, *The Nation: 1996 Census of Population*, Diskette product 93F003.

Figure 4.2
Distribution of Dwellings by Province, 1996



4.2 GROWTH PROJECTIONS

CMHC projections indicate that there will be a net increase of approximately 2.5 million households in Canada during the 1996-2011 period. This will result in about 13.3 million households by 2011, compared to 10.8 million in 1996. The primary market for greenhouse gas reductions is thus in the existing housing stock. However, given the growth in number of households, and the demolition and replacement of some existing stock, it is clear that significant opportunity also exists in new housing.

Although the growth rates will decline in comparison to the rates experienced during the 1970's and late 1980's (due to the aging of the population), immigration and worker migration are generating strong growth in Ontario, Alberta and British Columbia. The forecasts suggest a slight shift away from single detached to multi-unit dwellings, perhaps a reflection of the fact that household size is declining. Many one-person households will be comprised of older residents.

4.3 AGE OF THE STOCK

At the national level, more than 20% of the dwellings were built before 1950, and almost 30% date from the 1950-1970 period. While a considerable portion of the stock in these categories will have undergone some renovation, experience suggests that much of this renovation activity did not fully incorporate energy efficiency measures. About 50% of existing dwellings were built after 1970; much of this stock has never

been upgraded. At the provincial level, not surprisingly, central Canada and the eastern provinces contain a considerable percentage of older stock.

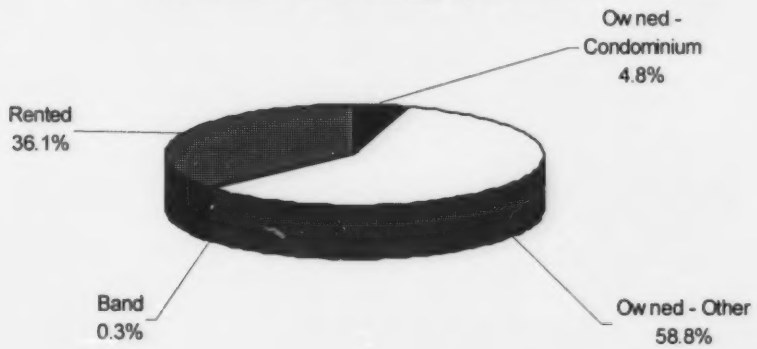
Significant percentages of space heating equipment fall into age brackets where there will be replacement opportunities in the near term. Natural Resources Canada's *Energy Use Outlook* attributes large energy savings over the next decade to the replacement of older inefficient space heating equipment and appliances with relatively efficient new products. That is, the replacement will occur anyway as the useful life of the equipment comes to an end; however, there is the opportunity to accelerate this cycle.

4.4 OWNERSHIP

Figure 4.3 breaks down the distribution of dwelling types by tenure.[10] As shown, housing units in Canada are predominately occupied by owners: 63% own their own homes while 37% rent their dwelling. Breaking these numbers down further, single detached houses are occupied predominately by owners (nearly 90%), while in contrast, about 84% of apartments (5 or more stories) are rented.

Tenure varies by province. The heaviest concentrations of rented dwellings are in Quebec, Ontario, Alberta, and British Columbia. Most of the single owned, detached dwellings are located in the same four

Figure 4.3
Distribution of Dwellings by Tenure



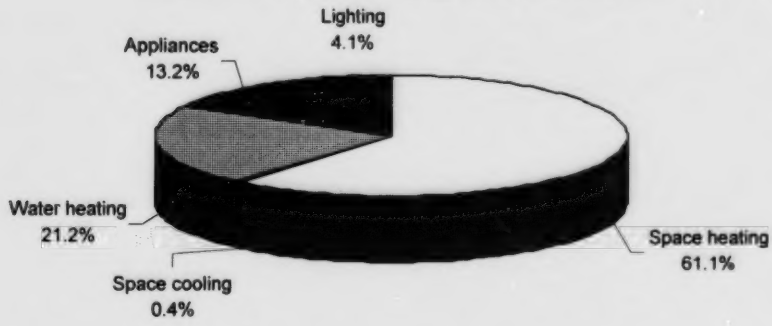
provinces: Quebec, Ontario, Alberta, and British Columbia.

[10] Statistics Canada, *The Nation: 1996 Census of Population*, Diskette product 93F003.

4.5 ENERGY USE IN THE SECTOR

In 1996 the residential sector accounted for about 19% of total secondary energy use in Canada. Space and water heating account for about 82% of total residential energy consumption, of which 61% is for space heating. Further information on distribution by end use is presented in Figure 4.4.

Figure 4.4
Distribution of Residential Energy Use by End-Use, 1996



The pattern of energy end use varies somewhat among dwelling types. For example, the share attributed to space heating in single detached dwellings is approximately 60%. For mid-and high-rise apartment buildings, the share for space heating ranges from 28% to 60%.

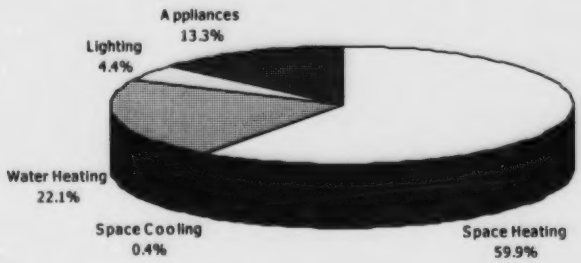
Natural Resources Canada data show that overall energy use in the sector is growing, and the energy use per dwelling is also growing, after a decline in the 1990 to 1995 period. Several factors are contributing to higher energy consumption, offsetting some of the large improvements in the efficiencies of regulated space-heating equipment and appliances over the past decade:

- Regional trends to exposed basement walls or replacement with crawlspaces, leaving more of the house envelope exposed to the elements
- Increasing house size of 1.4% per year
- Increasing window area due to improved window technologies and consumer preference
- Larger water heaters to supply hot tubs and Jacuzzis
- Increased lighting, including landscape lighting and indirect indoor lighting
- Hybrid heating systems to improve comfort and aesthetics, including in-floor radiant heating and the proliferation of gas fireplaces
- Increases in the penetration of electronic equipment and minor appliances.

4.6 GHG EMISSIONS IN THE SECTOR

In 1995, residential sector GHG emissions represented 12% of all of Canada's GHG emissions. Figure

Figure 4.5
Residential GHG Emissions by End Use 1996



4.5 provides a breakdown of residential sector GHG emissions by end use for 1996.

Exhibit 4.1[11] provides information on total GHG emissions from residential energy use, both direct (i.e. emissions on-site) and indirect (associated with electricity use, with emissions at the point of generation). As shown, in 1990 total GHG emissions (all residential) amounted to 72.6 Mt CO_2 equivalent. This amount is expected to fall to about 68 Mt in 2000 before rising again to 71.3 Mt in the "business-as-usual" (BAU) Scenario.[12]

This data includes mid and high rise residential buildings, which are not addressed by the Measures presented in this Options Paper. Accordingly, Exhibit 4.1 also presents information on low rise residential GHG emissions, net of the mid and high rise segments. This information is presented again in graphic form in Figure 4.6.

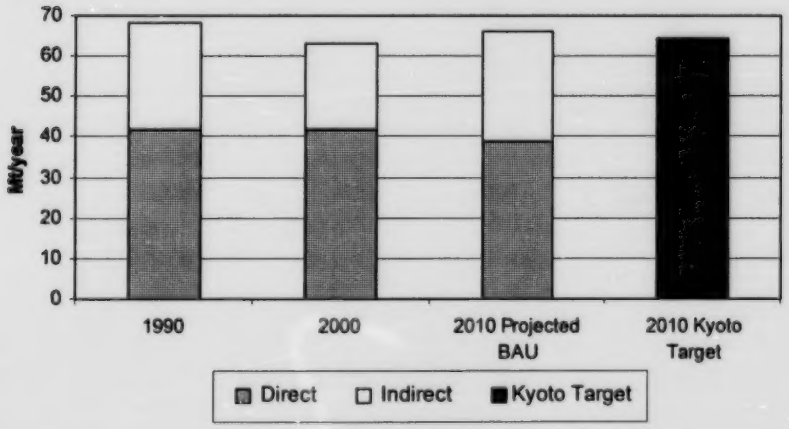
[11] Source of "all residential" data in table is *Canada's Emissions Outlook, An Events-Based Update for 2010*, presented by NRCan to the Buildings Table on June 22-23, 1999. Mid and high rise data derived by Marbek/SAR/Sheltair.

[12] Energy related GHG emissions are influenced by total energy use *and* by fuel mix. Consequently, changes in GHG emissions do not necessarily match changes in total energy use during the same period.

Exhibit 4.1
Residential GHG Emissions (Mt CO_2 equivalent)

		BAU			Kyoto Target
		1990	2000	2010	
Direct emissions	All Residential	44.1	44.5	41.7	
	Less Mid/Hi Rise Residential	2.4	2.7	2.9	
	Low Rise Emissions - Direct	**41.7**	**41.8**	**38.8**	
	Relative to 1990			-7.0%	
Indirect emissions	All Residential	28.5	23.5	29.6	
	Less Mid/Hi Rise Residential	1.8	2.0	2.2	
	Low Rise Emissions - Indirect	**26.7**	**21.5**	**27.4**	
	Relative to 1990			2.6%	
Total emissions	All residential	72.6	68.0	71.3	
	Less Mid/Hi Rise Residential	4.2	4.6	5.1	
	TOTAL LOW RISE EMISSIONS	**68.4**	**63.4**	**66.2**	**64.3**
	Relative to 1990			-3.2%	-6.0%

Figure 4.6
Residential Low Rise GHG Emissions (in Mt CO_2 equivalent)



As illustrated, for the low rise residential segment, GHG emissions were estimated to be 68.4 Mt CO_2 equivalent in 1990. Emissions are projected to be 63.4 Mt in 2000, rising to 66.2 Mt in 2010. This is 3.2% below 1990 levels. The Kyoto target of 6% below 1990 levels, if applied to the low rise residential sector emissions, would amount to 64.3 Mt. Meeting the Kyoto target of 6% reduction implies the need for measures that yield a minimum GHG reduction of approximately 2 Mt compared to the Business-as-Usual Scenario presented here.

In these projections, direct GHG emissions in 2010 are 7% below 1990 levels, whereas indirect emissions are 2.6% above 1990. These differing trends arise primarily because electricity use (indirect emissions) is expected to grow in the residential sector, driven by increasing penetration and use of electrical equipment and appliances. Conversely, for the energy end uses most associated with direct emissions, continuing efficiency improvements are anticipated (for instance, increasing penetration of efficient furnaces).

Note that the residential business-as-usual scenario includes a number of important assumptions that need to be considered in the design of greenhouse gas reduction Measures, including:

- All new gas furnaces will be high efficiency (92%) beginning in the year 2005, and the existing stock of furnaces will turn over on a 20 year cycle.

- By 2010, the thermal performance of new house construction will be 5% above the Model National Energy Code for Houses, average house size will remain unchanged, and R-2000 level houses will account for 3% of new construction.

- New efficiency regulations will be adopted for certain appliances, reducing energy use to varying degrees depending on the appliance.

HRAI wishes to record a dissenting opinion with respect to the business-as-usual assumption that all new gas furnaces will be high efficiency (92%) beginning in the year 2005. It is the view of HRAI that a decision to regulate gas furnaces at this level has not been taken, and that any such decision would need to consider the issue of harmonization with regulations in the United States.

4.7 STAKEHOLDERS AND DECISION-MAKERS

The residential building industry is made up of a large and fragmented group of stakeholders, as indicated in Exhibit 4.2 below.

Exhibit 4.2
Residential Building Industry Stakeholders

Federal Government	*Municipal Government*	*Utility Companies*
·Natural Resources Canada	·Planning	·Electricity
·National Energy Board	·Engineering	·Natural Gas
·National Research Council /IRC	·Permits	·Oil
·PWGSC		·Propane
·CMHC	*Private Sector*	
·Revenue Canada		*Building Occupants*
·Industry Canada	·Builders/Renovators	
	·Developers	·Owners
Provincial Government	·Designers, Architects, Engineers	·Tenants
	·Product Manufacturers	
·Energy & Environment Ministries	·Product Distributors	*Home Buyers*
·Municipal Affairs and Housing	·Standards Organizations	
·Utilities Commissions	·Financial Institutions	*Advocacy Groups*
	·Performance Contractors	
	·Home Inspectors	·Industry Associations
	·Building Trades	·Consumer Associations
	·Building Consultants	·Environmental Groups
	·Building Owners	

It is important to recognize the role of decision-makers in the sector. A complex mixture of federal, provincial and municipal regulations, taxes and charges, market forces, policy, demographics, and regional economics define the environment in which housing is designed, built, purchased, operated, and renovated. Generally, decisions made at higher levels in the stakeholder map will directly affect the potential range of decisions that can be made at lower levels. For example, federal energy efficiency regulations dictate the minimum efficiencies of appliances and equipment available for selection and installation in new and existing homes. Inefficient products are removed from the marketplace, leaving consumers and builders/renovators the choice of good or better products. Collectively, these incremental improvements generate significant savings over the long term.

5. OPPORTUNITIES TO REDUCE GHG EMISSIONS

The *Foundation Paper* prepared for the Buildings Table presented a range of potential technological and behavioural approaches for reducing GHG emissions in the residential sector. Briefly, the identified approaches included:

Improved Utilization of Housing

- Improve the use of presently under-utilized spaces (e.g., basements)
- Encourage densification
- Reduce the size of new dwellings.

Reduce initial and recurring embodied energy

Change occupant behaviour

Reduce operating energy

- Space conditioning (heating, cooling, ventilation)
- Building envelope
- Windows
- Controls
- Water heating
- Lighting
- Appliances and other equipment (including outdoor equipment).

Promote alternative energy supply systems

- Active solar hot water heaters
- Active and passive solar space heating & cooling
- Photovoltaics
- Wind turbines (building cluster or community level)
- Air source and ground source heat pumps
- Co-generation and shared energy systems (building cluster or community level)
- Fuel cells.

In consideration of these opportunities, a series of actions were identified for analysis, as outlined previously in Section 3. In total, 27 actions were initially analysed for potential greenhouse gas impact, and for

lifecycle cost per tonne of GHG emission reduction. The results were presented in the report *Commercial/Institutional and Residential Sector Action/Opportunity Cost Curves.*[13]

Based on this report, the Buildings Table reviewed the actions and potential Measures, and expanded and modified the list of actions significantly. Moreover, as noted in Section 3.3, the changes to the NRCan business-as-usual scenario have led to redefinition of some of the actions. In view of these changes, an entirely new and expanded list of actions was used in the Measures analysis in this report.

The new list of 44 actions is presented in Appendix A. Because of the significant changes, for reasons of readability the previous numbering scheme has not been retained. The action descriptions, rather than numbers, should be used as the basis for correlating the original and current lists of actions.

[13] Marbek, Sheltair, and SAR *op.cit.*

6. LESSONS LEARNED

Over the past 15 years, there have been literally hundreds of initiatives directed at the residential sector energy market. The lessons learned have guided the Buildings Table in its consideration of possible Measures. In this section, a number of general lessons are outlined first, followed by a discussion of specific lessons associated with Canada's R-2000 program. Information in this section is drawn from the *Foundation Paper* prepared for the Buildings Table, supplemented by additional information provided by NRCan.

6.1 OVERVIEW OF LESSONS LEARNED

Based on experience in Canada and elsewhere, a number of important conclusions can be drawn:

- ***Government and other institutional interventions have played an important role in the area of residential energy efficiency.*** It is likely that only a small percentage of the energy efficiency gains achieved to date and, consequently the GHG emission reductions achieved so far, would have occurred in the absence of market interventions. Market interventions have increased the impact of energy efficiency measures through acceleration of the pace at which energy efficiency occurs in the market; expansion of the unit impact of measures (i.e., the savings); and expansion of the market for energy efficiency initiatives.

- ***There has been a transformation in the residential energy marketplace.*** The availability of energy efficient products and services is widespread. However, restructuring and deregulation of the energy supply market will affect the way in which energy is supplied and marketed. Deregulation will likely lead to lower energy prices for the consumer, which will undermine the cost effectiveness of energy efficiency measures. Further market transformation is needed, so that efficient equipment and designs become the norm.

- ***Market interventions have still fallen short in key sub-markets.*** Low-income and tenanted households, both in low- and high-rise structures, and new construction and major renovations are areas where energy efficiency opportunities have not been fully realized. There is a need to develop special policies and initiatives for reaching segments such as multi-unit residential buildings and low income housing.

- ***Market interventions don't always pay off.*** The cost of delivery is sometimes higher than the cost of the energy being displaced. Interventions should foster actions that would not have been undertaken in their absence. "Free riders" dilute the impacts of the programs, and are greater in number when actions with rapid payback periods are promoted and when actions have high current market shares. Measured savings from residential retrofit programs are often less than engineering estimates.

- ***Energy audits alone generally result in only limited energy savings. Information campaigns have limited impact.*** There is difficulty in moving from energy efficiency awareness to action.

- ***Marketing strategies and technical/construction support services have a large impact on program participation and services.*** Association with topnotch trade allies is essential.

- ***Financial incentives tend to increase program participation and savings.***

- ***Impact can be achieved by focussing on communities of people with similar values and concerns, rather than on individuals.*** For significant change, it is necessary to go beyond the individual consumer and start addressing the interest and actions of influencers and decision-makers, such as policy makers, designers, distributors, and others involved in the marketplace.

6.2 R-2000 PROGRAM

The R-2000 Program is highly relevant to the work of the Buildings Table. Important lessons can be drawn from direct program experience, and from the federal government's R-2000 evaluation:

- The program has achieved only very limited market penetration for certified R-2000 houses, but ***indirect impacts*** of the program were assessed by the program evaluation to be very high. The Program was an effective vehicle for bringing new technology and practices into the market. Many of the recent improvements in energy efficiency of new buildings can be directly attributed to the technologies and practices promulgated by the R-2000 program (such as improved air tightness and use of heat recovery ventilators).

- More generally, leading-edge programs such as R-2000 provide important support to technical advances in the industry. For instance, R-2000 has been instrumental in demonstrating the importance of using the principle of *house as a system* as a baseline for all program design activities.

- The incremental cost of building to R-2000 standards and levels is approximately 2% to 4% greater than the cost of new homes built using conventional building practice. Incremental costs were viewed by all players in the market as the single most important barrier to increased take-up.

- Program uptake is directly influenced by incentives, but the level of incentive need not cover the entire incremental cost of building to the R-2000 standard.

- The program is cost-effective from the government's perspective.

- Third party quality assurance is a key factor in the value of R-2000 to home buyers. Training programs for the industry are fundamental for such a program to succeed. Program marketing support is also important for the success of the program.

PART IV: OVERVIEW OF MEASURES

7. DESCRIPTION OF MEASURES

Exhibit 7.1 presents summary descriptions of each of the 16 Measures under consideration by the Buildings Table. More detailed ***Measure Profiles*** are presented for each Measure in Appendix B, and summary analysis of the impact of these Measures is provided beginning in Section 9.

Later in this report, the Measures will be divided into Options Packages. For ease of reference and consistency of presentation, in this document the Measures are always presented in a standard sequence based on these Options Packages. In Exhibit 7.1, the reference to Options Packages is for presentation purposes only. Further discussion of these Packages is provided in Section 10.

Exhibit 7.1
Presentation of Residential Measures

Measure	Description of Measure
Measures Included in Options Packages A and B (see Section 10)	
R-3: National Energy Efficient Housing Renovation and Retrofit Program **Type: Suasion/incentive**	This Measure is designed as a comprehensive and integrated initiative to encourage consumers to upgrade the efficiency of existing homes. It includes: incentives to retrofit/renovate (tax breaks such as removal of GST, PST, HST, and/or accelerated depreciation of costs in rental housing); access to financing; home energy audits and labelling (Energuide for Houses); renovator training/certification; a retail element including sales force training; and involvement of community based delivery agents (e.g., Green Communities).
AE-1: National Standards Program for Equipment and Appliances **Type: Regulatory**	This Measure involves minimum efficiency standards for a range of products, with new standards introduced in 2004. Products to be addressed would include HVAC equipment (including HRVs); major appliances; domestic water heaters; lighting; windows and doors; motors; and gas fireplaces. Energuide labelling would also be included for most products.
AE-5: Premium Energy Performance Labelling Program for Equipment and Appliances **Type: Suasion**	This Measure involves a Premium Energy Performance label for the top performers within each product category (say top 15-20%, but varying by category). Products to be addressed by this measure would include: HVAC equipment (including HRVs); major appliances; domestic water heaters; lighting; windows and doors; motors; and gas fireplaces.
AE-8: Equipment Leasing Facilitation Program **Type: Suasion**	This Measure would facilitate uptake of new technology through leasing arrangements, removing risk factors for owners. It depends on private sector initiative involving both the manufacturers of the equipment in question, and financial and leasing companies. To encourage development of an industry-wide initiative, leadership by industry associations will be essential.

Measure	Description of Measure
R-7V: Energuide for Houses Program - Voluntary **Type: Suasion**	This Measure is an extension and expansion of existing programs to promote purchase of energy efficient new and existing homes. Households that wish to participate would receive a home energy audit and, based on the results of the audit and any retrofit actions undertaken, these houses would be rated/labelled with respect to energy efficiency. Renewable energy measures in the home would also be reflected in the rating. Note: A voluntary Energuide for Houses is also incorporated in Measure R-3.
R-6B: R-2000 for Existing Dwellings Renovation Program **Type: Suasion/incentive**	This market leadership program is similar in concept to the R-2000 program for new housing. Specifically, the program will encourage and support high level retrofit of a small portion of the existing housing stock across the country. It will incorporate key features of the established R-2000 program. This will likely include: development of an R-2000 retrofit guideline incorporating high levels of energy efficiency and advanced retrofit techniques; training and certification of R-2000 retrofit contractors; independent evaluation and certification of R-2000 retrofits; and strong marketing of the program and its benefits.
R-5A: Strengthened R-2000 Program **Type: Suasion**	This Measure involves strengthening the R-2000 program. The target is to shift the market so that certified R-2000 homes achieve a penetration rate of 10% of new construction (compared to a business-as-usual penetration of 3%). This will require more resources for marketing, access to preferred mortgage rates (in cooperation with the banking community), expanded builder training and certification, and streamlined requirements and certification process. This expansion will require strong commitment from governments and industry.
R-1A: Assisted Housing Program **Type: Suasion**	This is a Measure to undertake energy efficiency improvements in the social housing/assisted housing stock. The financing is expected to involve funding from provincial or federal sources, loans from provincial or municipal revolving funds, leveraged involvement of private sector financial institutions, and/or other alternative financing approaches.
R-1B: Low Income Housing Program **Type: Suasion/incentive**	This Measure is designed to provide financing and assistance for energy efficiency improvements in the low income owner-occupied stock (retrofit, weatherization, heating systems, etc.). Grants of up to $10,000 (notional) would piggyback on the RRAP program. Additional financing would involve loans from provincial or municipal revolving funds, leveraged involvement of private sector financial institutions, and/or other alternative financing approaches. This targeted Measure would be supported by the several elements of Measure R-3.
R-6A: Housing Energy Technology Demonstration Program **Type: Suasion**	This is an enabling measure intended to generate long-term improvements in energy efficiency in housing. Elements would include: demonstration of new design approaches; demonstration of "market-ready" technology (advanced integrated mechanical systems, renewable energy technologies, home automation technology, etc.); and extension activities relating to the demonstrations (preparation of guidelines, dissemination of information, workshops, etc.).

Measure	Description of Measure
AE-4: Technology Commercialization Program (Includes Renewable Technologies) **Type: Suasion**	This Measure would promote technologies such as integrated systems/heat pumps; solar and instantaneous domestic hot water heating systems; advanced lighting technologies; ground source heat pumps; and other proven technology that has not yet developed a significant market in Canada.
R-10: Residential Retrofit Guidelines and Installation Standards **Type: Suasion**	This is an enabling Measure designed to improve the energy efficiency of renovations and equipment installations. The guidelines and standards would support other proposed Measures, and adherence to the guidelines/standards would be encouraged or required in these Measures. The guidelines/standards would also be available for use/adoption by, for instance, individual companies, industry associations, municipalities, and other agencies involved in retrofit.
Additional Measures Included in Options Package B (see Section 10)	
R-4A: Adoption of More Stringent MNECH by Provinces **Type: Regulatory**	This Measure sets in place provincial minimum energy efficiency regulations for new housing and major additions, based on a revised and more stringent Model National Building Code for Houses (MNECH). In five provinces, this would involve replacement/ harmonization of existing codes with the more stringent MNECH; in the other provinces, it would involve adoption of an energy code for the first time.
R-7M: Energuide for Houses Program - Mandatory **Type: Regulatory**	This Measure is a mandatory variant of the Energuide for Houses program described above (Measure R-7V). As with the voluntary alternative, participants would receive a home energy audit and, based on the results of the audit and any retrofit actions undertaken, these houses would be rated/labelled with respect to energy efficiency. In the mandatory alternative, home owners and builders would be required to obtain the Energuide label prior to the sale of any home.
AE-6: Reduced Sales Tax to Encourage Purchase of EE Products in New Construction **Type: Incentive**	This Measure would remove the GST/PST/HST from energy-saving equipment and products used in new construction (or alternatively provide other equivalent tax reduction). A primary focus would be on appliances and equipment addressed by Measure AE-5 (Premium Energy Performance Labelling Program for Equipment and Appliances), but insulation and renewable energy technologies would also be included in the program. Eligibility would be restricted to new construction achieving specified levels of energy performance. Note: Similar tax reductions are proposed for existing housing through Measure R-3.
Other Measures That Merit Consideration	
R-11: Building Permit Feebates	This Measure proposes to base building permit fees on the level of energy efficiency of a new building, as determined at the plans review stage. This Measure is conceived to be revenue-neutral for the municipality: building permit rebates for more efficient housing would be offset by increased fees for less efficient housing. This "feebate" is, in effect, a form of emissions credit. The Buildings Table has referred this Measure to the Municipalities Table for consideration.

In addition to the above 16 Measures, the Table also considered a number of other candidates. Some of these additional candidate Measures were referred to other Tables (see Section 8), and some were

incorporated into the above Measures. In addition, the following Measures were analysed by the Table, and judged not to warrant further consideration:

R-8V: Fuel Choice/Fuel Switching – Voluntary	This Measure would encourage consumers in selected jurisdictions to opt for energy sources with lower greenhouse gas emissions. The Measure involves information on options, recognition of fuel choice/ fuel switching in other Measures (such as R-3), and a financial incentive of $500 per participant. **This Measure has been dropped from further consideration.**
R-8M: Fuel Choice/Fuel Switching – Mandatory	This Measure is a mandatory variant of the Fuel Choice/ Fuel Switching program described above (Measure R-8V). This Measure would require consumers in selected jurisdictions to opt for energy sources with lower greenhouse gas emissions, for new construction and for natural equipment replacement in existing housing. **This Measure has been dropped from further consideration.**

These two Measures are not discussed further in this Options Paper.

8. MEASURES FOR CONSIDERATION BY OTHER TABLES

As noted in Section 7, a number of Measures identified by the Buildings Table have not been pursued further, in recognition that these Measures are better dealt with by other Issue Tables. These Measures are presented in Exhibit 8.1, along with a brief description. With the exception of R-11 (Building Permit Feebates), the listed Measures were identified but not analysed by the Buildings Table.

Exhibit 8.1
Measures for Consideration by Other Tables

MEASURE	RECOMMENDATION
R-11 **Building Permit Feebates**: This Measure was analysed by the Buildings Table. A profile of this Measure is presented in Appendix B.	Refer to Municipalities Table
RT-4 **Promotion of Green Power Purchases** Application: Electricity supply Description: Modification of existing utility rate structures to allow consumers to purchase a percentage of their electricity generated by renewable energies (at a premium). Also, the wheeling of green power would be accepted in all provinces.	Refer to Electricity Table
O-1a **Environmental Costing of all Energy Supply Sources** Application: General Description: Government-mandated energy pricing adders to account for environmental costs of energy sources O-1b **Adoption of Innovative Electricity Rate Structures** Application: General Description: Modification of utility rate structures to encourage energy efficiency O-1c **Rate of Return for Utility Energy Efficiency Services** Application: General Description: Utility Boards and Commissions in restructured electricity market to support competitive rates of return for energy efficiency services supplied by utilities	Refer to AMG or appropriate table
O-2 **Level Playing Field for all Energy Sources** Application: General Description: This measure would ensure that the tax treatment of all energy sources was equalized.	Refer to AMG or appropriate table
O-3 **National Climate Change Loan Fund** Application: General Description: This measure is essentially a revolving fund(s) designed to provide financing for community level projects that result in significant reduction of GHG emissions. Activities include energy efficiency retrofits and renewable energy installations. The money could be accessed by municipalities and other groups to implement community level activities.	Refer to Municipalities Table

MEASURE	RECOMMENDATION
O-4A **Climate Change Information Services** Application: Public and private sector individuals and organizations looking for sustainable development, construction, renovation, and technology information Description: "One-stop shopping" at the national level linked to either the community, provincial, or regional level for information on residential and commercial EE information, guidelines, and programs	Refer to Public Education and Outreach Table
RT-3 **Promotion of Renewable Energy and Green Power** Application: General Description: Comprehensive promotion and information program. Promotion could include, among other things, a web site to list suppliers, products, resource database, etc. General promotion and information using all media could be provided. Marketing support for the industry could also be included.	Refer to Public Education and Outreach Table

PART V: OVERVIEW OF TABLES FINDINGS

Part V consists of four main sections:

- Section 9 summarizes the results of the analysis of individual Measures.
- Section 10 introduces the proposed Options Packages developed by the Table, and outlines the relationship between these Packages and the Measure categories defined by the National Climate Change Secretariat.
- Section 11 presents the results of the analysis of the Options Packages, including aggregate GHG impacts and costs.
- Section 12 presents the Table's observations concerning additional work required.

9. SUMMARY OF ANALYSIS OF MEASURES

9.1 GHG IMPACTS AND COST PER TONNE

In this section, a summary of the modelling outputs for each Measure is presented. (Appendix B provides more detailed information on each Measure, including data sheets that describe the modelling results.)

Figures 9.1 and 9.2 below summarize the national greenhouse gas impact, and cost per tonne of GHG reduction, for all Measures. Specifically, Figure 9.1 shows results assuming marginal electricity is derived from natural gas, which is consistent with the data presented Measure-by-Measure in Appendix B. Figure 9.2, on the other hand, assumes a regional mix for the marginal generation. (For discussion of this issue, see Part II, Section 3.3.).

Exhibit 9.1 provides the same information as Figure 9.1, in tabular format.

Note that cost per tonne figures are based on total GHG reduction stimulated by the Measure (i.e. total reductions over the life of the various actions stimulated by the Measure).

Figure 9.1
National Impact of Residential Sector Stand Alone Measures
(marginal electricity based on natural gas generation)

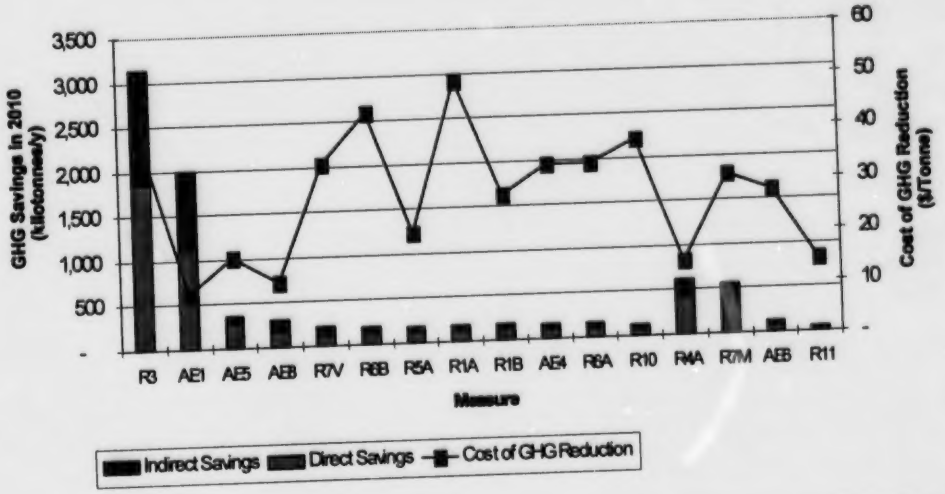
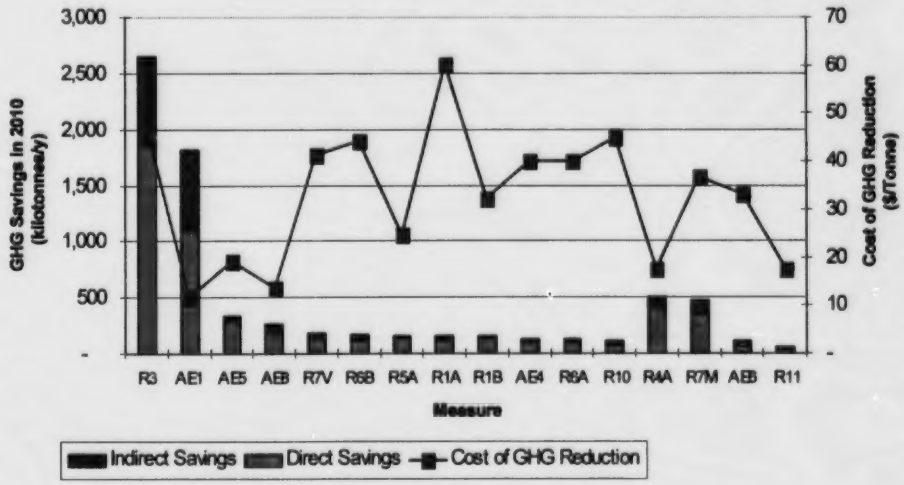


Exhibit 9.1
Summary of residential GHG reductions and cost per tonne
(marginal electricity based on natural gas)

Measures		GHG reductions in 2010 (kilotonne/yr)	Cost per tonne of GHG reduction ($/tonne)
R-3	National Energy Efficient Housing Renovation and Retrofit Program	3144	$40
AE-1	National Standards Program for Equipment and Appliances	1999	$11
AE-5	Premium Energy Performance Labelling Program for Equipment and Appliances	367	$17
AE-8	Equipment Leasing Facilitation Program	300	$12
R-7V	Energuide for Houses Program – Voluntary	219	$35
R-6B	R-2000 for Existing Dwellings Renovation Program	201	$44

Figure 9.2
National Impact of Residential Sector Stand Alone Measures
(marginal electricity based on regional marginal generation)



R-5A	Strengthened R-2000	179	$21
R-1A	Assisted Housing Program	178	$50
R-1B	Low Income Housing Program	177	$28
R-6A	Housing Energy Technology Demonstration Program	157	$34
AE-4	Technology Commercialization Program	157	$34
R-10	Residential Retrofit Guidelines and Installation Standards	126	$38
R-4A	Adoption of More Stringent MNECH by Provinces	615	$14
R-7M	Energuide for Houses Program– Mandatory	564	$31
AE-6	Reduced Sales Tax to Encourage Purchase of EE Products in New Construction	126	$28
R-11	Building Permit Feebates	62	$14

A number of observations can be made, based on the above data.

- There is a wide range of greenhouse gas reductions associated with the various Measures, ranging from a low of less than 100 kt of CO_2 equivalent, to a high of over 3000 kt. Looking at the Measures on an stand-alone basis, the two largest Measures generate about 60% of the total GHG reductions modelled for the individual Measures (this percentage is an approximation, and has not been corrected for overlap between Measures, as discussed below).

- Based on the current NRCan business-as-usual scenario, the suasion Measures alone would reduce emissions in 2010 to a level approaching 6% below 1990 levels. Similarly, either Measure AE-1 or Measure R-3 would reduce emissions to 6% or more below 1990. The impact of these Measures during the period following 2010, when emissions in the business-as-usual scenario increase significantly, has not been modelled.

- The GHG reductions available in the existing housing stock are significantly greater overall than the reductions available in new housing. This is in part due to the relative size of the existing vs new housing stock. New housing is also substantially more efficient than the existing stock, with the result that the opportunities for greenhouse gas reduction are more limited.

- The costs per tonne of GHG reduction are positive in all cases, based on the methodology used (as specified by the Climate Change Secretariat). The lowest costs per tonne are generally associated with the equipment and appliance measures, and with new housing. Those Measures that address renovation and retrofit of existing housing are, as expected, the most expensive (but also the areas with the greatest GHG reduction potential).

It is important to re-iterate that the Measures presented above have been analysed on a "stand alone" basis. This means that the analysis identifies what would be achieved by each Measure on its own. It cannot be assumed that the combined impact of a group of Measures will be the sum of the impacts of the individual Measures (because the various Measures may be targeting some of the same efficiency gains).

The following additional observations elaborate on this point:

- The impacts of *some* Measures will in fact be additive. For instance, the impacts of Measures that target different segments of the market can in principle be added.

- Other Measures are, by design, intended to be complementary – for instance, Measures AE-6 (Reduced Sales Tax to Encourage Purchase of EE Products in New Construction) and AE-1 (National Standards Program for Equipment and Appliances). While the modelled impacts of the two Measures may not be fully additive, their complementary nature means that the impacts of the two together would be greater than the impacts of either one alone.

- Finally, some Measures may be redundant with other Measures (that is, they offer alternative approaches for achieving particular efficiency improvements).

9.2 ALTERNATIVE PRESENTATION OF COST PER TONNE

In the above figures, and in the results presented in Appendix B, the data concerning cost per tonne for GHG reductions is calculated ***based on total GHG reductions*** (i.e., total reductions over the life of the various actions stimulated by the Measure). Alternatively, the cost per tonne could be presented ***based on GHG reductions in the year 2010.*** For information purposes, this alternative presentation of cost per tonne is shown in Exhibit 9.2 for each of the Measures.

Exhibit 9.2
Cost per tonne for residential GHG reductions (marginal electricity based on natural gas)

Measure		Cost per tonne for GHG reductions (rounded)	
		Based on total reductions ($/tonne)	Based on reductions in 2010 ($/tonne/y)
R-3	National Energy Efficient Housing Renovation and Retrofit Program	$40	$800
AE-1	National Standards Program for Equipment and Appliances	$11	$220
AE-5	Premium Energy Performance Labelling Program for Equipment and Appliances	$17	$340
AE-8	Equipment Leasing Facilitation Program	$12	$240
R-7V	Energuide for Houses Program - Voluntary	$35	$700
R-6B	R-2000 for Existing Dwellings Renovation Program	$44	$880
R-5A	Strengthened R-2000 Program	$21	$420
R-1A	Assisted Housing Program	$50	$1,000
R-1B	Low Income Housing Program	$28	$560
R-6A	Housing Energy Technology Demonstration Program	$34	$680
AE-4	Technology Commercialization Program	$34	$680
R-10	Residential Retrofit Guidelines and Installation Standards	$38	$760
R-4A	Adoption of More Stringent MNECH by Provinces	$14	$280
R-7M	Energuide for Houses Program– Mandatory	$31	$620
AE-6	Reduced Sales Tax to Encourage Purchase of EE Products in New Construction	$28	$560
R-11	Building Permit Feebates	$14	$280

9.3 OTHER IMPACTS

The analysis of the individual Measures presented in Appendix B includes a preliminary discussion of economic, social, environmental, and health impacts of each Measure. Although each Measure is unique, in most cases the assessment identified more positive than negative impacts. Where there are specific issues of potential concern associated with a Measure, these are identified in Appendix B.

One area that received particular attention was the potential impact of the Measures on affordability of housing. This issue was addressed in a supplementary study supported by CMHC.[14] While most of the analysis done for the Buildings Table focussed on the aggregate level in accordance with the Climate Change Secretariat (AMG) guidelines, the supplementary study undertook a cost analysis at the household level. The premise of the study was that Measure costs that may be reasonable from a societal perspective can nonetheless have potentially negative impacts on low income households. The study concluded that the proposed regulatory Measures (R-4A and AE-1) would reduce housing affordability. This conclusion was not supported by some members of the Buildings Table. Further discussion is provided in Appendix B of this report.

[14] Lampert, Greg and Steve Pomeroy, *Economic Impacts of Proposed EE Measures on the Housing Industry and Consumers*, July 1999. This study was undertaken based on initial modelling results for selected Measures. After completion of the supplementary study, the Buildings Table further refined the Measures. These changes to the Measures would affect some of the detailed results of the Lampert and Pomeroy analysis, but would not be expected to affect the overall conclusions.

10. DESCRIPTION OF POSSIBLE OPTIONS PACKAGES

10.1 INTRODUCTION

In this section, two Options Packages are presented, as developed by the Table at its meeting of July 27, 1999. Each package consists of a set of Measures that, taken together, could be viewed as a comprehensive climate change program for the residential sector.

Package A includes:

- All of the suasion-type Measures (e.g. R-5A Strengthened R-2000 Program)
- *AE-1 National Standards Program for Equipment and Appliances*
- Two broad retrofit Measures: *R-3 National Energy Efficient Housing Renovation and Retrofit Program*, and *R-6B R-2000 for Existing Dwellings Renovation Program*
- Two additional retrofit Measures targeted at specific segments of the existing housing market: *R-1A Assisted Housing Program*, and *R-1B Low Income Housing Program.*

Package A is the minimum package recommended by the Buildings Table. Dissenting views were expressed by John Haysom (National Research Council) with respect to the inclusion of R-3, and by CHBA with respect to the inclusion of AE-1 and R-3 (as currently defined).

Package B includes:

- All of the Measures from Package A
- An additional incentive Measure: *AE-6 Reduced Sales Taxes to Encourage Purchase of EE Products in New Construction*
- Two regulatory Measures: *R-4A Adoption of More Stringent MNECH by Provinces*, and *R-7M Energuide for Houses Program - Mandatory.*

Additional dissenting views were expressed by CHBA and the representative from Fall River Village Ltd. with respect to the inclusion of the regulatory Measures in any Options Package. CHBA also expressed a dissenting view with respect to inclusion of AE-6 in this Options Package.

The two Options Packages are summarized below in Exhibit 10.1. Within each package, the Measures are listed in order of estimated GHG reduction impact (largest impact first).

Note that the two Options Packages do not include three of the Measures previously considered by the Table. Measure *R-11 Building Permit Feebates* has been referred to the Municipalities Table, and the Buildings Table has determined that Measures *R-8M Fuel Choice/Fuel Switching - Mandatory* and *R-8V Fuel Choice/Fuel Switching - Voluntary* do not merit further consideration.

Exhibit 10.1
Overview of Residential Options Packages

Package A	R-3 National Energy Efficient Housing Renovation and Retrofit Program AE-1 National Standards Program for Equipment & Appliances AE-5 Premium Energy Performance Labelling Program for Equipment and Appliances AE-8 Equipment Leasing Facilitation Program R-7V EnerGuide for Houses Program - Voluntary R-6B R-2000 for Existing Dwellings Renovation Program R-5A Strengthened R-2000 Program R-1A Assisted Housing Program R-1B Low Income Housing Program R-6A Housing Energy Technology Demonstration Program AE-4 Technology Commercialization Program R-10 Residential Retrofit Guidelines and Installation Standards
Package B	Package A plus: R-4A Adoption of More Stringent MNECH by Provinces R-7M EnerGuide for Houses Program– Mandatory AE-6 Reduced Sales Tax to Encourage Purchase of EE Products in New Construction

10.2 SECRETARIAT CATEGORIES

The National Climate Change Secretariat has defined four categories of GHG reduction Measures, and has asked the Tables to divide their Measures into these categories. The categories are as follows:

- **Category 1: Core Measures** (suitable for immediate implementation)
- **Category 2: Prospective Measures** (should play a role in Canada's strategy, but may require additional analysis, broader consultation, or are conditional on international developments)
- **Category 3: Measures that Merit Consideration** (insufficient information to form a judgement)
- **Category 4: Measures that do not Merit Further Consideration.**

In its deliberations, the Buildings Table developed criteria for assigning Measures to these categories, and made an initial determination of the appropriate category for each Measure. At its meeting of July 27, 1999, the Table revised the initial categorization to align with the Options Packages noted above.

For information purposes, Exhibit 10.2 below lists the category criteria developed by the Table, and presents the 16 residential sector Measures by category. The criteria are not absolute, but rather reflect the range of considerations that together determine the appropriate category for a Measure.

Exhibit 10.2
List of Residential Sector Measures

Category	Criteria	Measures
Category 1: Core Measures (suitable for immediate implementation)	• Significant GHG impact, and/or low life cycle cost • Other impacts of Measure expected to be neutral or positive overall • Program experience available to guide implementation • Achievable implementation requirements • Availability of "champions" ready to play a leadership role • No major unanswered questions regarding the Measure	All Measures included in Options Package A
Category 2: Prospective Measures	• Measure meets most of the Category 1 criteria, but • Significant unanswered questions remain, or • Measure requires a number of conditions (e.g. other Measures) to be well established prior to implementation.	Additional Measures included in Options Package B
Category 3: Measures that Merit Consideration	• Measure meets some of the Category 1 criteria • Significant additional research and analysis is required, or • The Measure may not be required to meet GHG targets	Measure R-11 Building Permit Feebates (referred to Municipalities Table)

As discussed in Part VI of this Options Report, the Table believes that the Measures in Options Package A/Category 1 will involve different levels of effort and different lengths of time to initiate. However, for these Measures, the Table believes that the necessary developmental steps can be initiated immediately, with actual launch of the various initiatives occurring on the schedule noted in Appendix B for each Measure.

In addition to the above criteria, CHBA has made further recommendations. They suggest that, before a measure is considered for Category 1, it should be tested against criteria such as:

- Efficiency - programs must meet clearly-defined goals in a cost-effective manner
- Equity - programs must treat participants in differing circumstances fairly
- Transparency - the costs of programs and their effects (both negative and positive) must be clearly apparent

- Duration - programs must cover an extended time period — not designed to meet a perceived short-term crisis

- Effect on housing consumers and the housing industry — programs must be in the long-term interests of both the housing industry and its consumers.

10.3 COVERAGE

To provide an indication of "coverage," Exhibits 10.3 and 10.4 present the Measures included in the Options Packages, sorted into categories:

- Exhibit 10.3 sorts the Measures into categories based on the focus of the Measure: existing housing, new housing, and equipment/appliances.

- Exhibit 10.4 sorts the Measures into categories based on the type of the Measures: suasion, incentive, and regulatory.[15]

Exhibit 10.3 shows that the Options Packages provide broad coverage of new and existing housing, and of equipment and appliances. Exhibit 10.4 indicates that the majority of Measures fall into the suasion category, but each of the packages also includes incentive and regulatory Measures.

[15] Measure R-1A (Assisted Housing Program) involves agencies responsible for social housing. It can be characterized as direct action by the responsible authorities, and as such, does not fit well into any of these categories. In Exhibit 10.4 and elsewhere in this report, R-1A has been listed as a suasion Measure.

Exhibit 10.3
Residential Options Packages Sorted by Focus of Measure

	Existing Housing	New Housing	Equipment and Appliances
PACKAGE 'A'	R-6A Housing Energy Technology Demonstration Program	R-6A Housing Energy Technology Demonstration Program	R-6A Housing Energy Technology Demonstration Program
	R-7V Energuide for Houses Program - Voluntary	R-7V Energuide for Houses Program - Voluntary	AE-1 National Standards Program for Equipment and Appliances
	R-3 National Energy Efficient Housing Renovation and Retrofit Program	R-5A Strengthened R-2000 Program	AE-5 Premium Energy Performance Labelling Program for Equipment and Appliances
	R-6B R-2000 for Existing Dwellings Renovation Program		AE-8 Equipment Leasing Facilitation Program
	R-10 Residential Retrofit Guidelines and Installation Standards		AE-4 Technology Commercialization Program
	R-1B Low Income Housing Program		
	R-1A Assisted Housing Program		
PACKAGE 'B' (*Package 'A' Plus*)	R-7M Energuide for Houses Program - Mandatory	R-7M Energuide for Houses Program - Mandatory	
		R-4A Adoption of More Stringent MNECH by Provinces	
		AE-6 Reduced Sales Tax to Encourage Purchase of EE Products in New Construction	

Exhibit 10.4
Residential Options Packages Sorted by Type of Measure

	Suasion	Incentive	Regulatory
PACKAGE 'A'	R-3 National EE Housing Renovation and Retrofit Program	R-3 National EE Housing Renovation and Retrofit Program	AE-1 National Standards Program for Equipment and Appliances
	R-6B R-2000 for Existing Dwellings Renovation Program	R-6B R-2000 for Existing Dwellings Renovation Program	
	R-1B Low Income Housing Program	R-1B Low Income Housing Program	
	R-1A Assisted Housing Program		
	R-6A Housing Energy Technology Demonstration Program		
	R-5A Strengthened R-2000 Program		
	R-7V Energuide for Houses Program - Voluntary		
	AE-4 Technology Commercialization Program		
	AE-8 Equipment Leasing Facilitation Program		
	AE-5 Premium Energy Performance Labelling Program for Equipment and Appliances		
	R-10 Residential Retrofit Guidelines and Installation Standards		
PACKAGE 'B' (*Package 'A' Plus*)		AE-6 Reduced Sales Tax to Encourage Purchase of EE Products in New Construction	R-4A Adoption of More Stringent MNECH by Provinces
			R-7M Energuide for Houses Program - Mandatory

11. ANALYSIS AND DISCUSSION OF OPTIONS PACKAGES

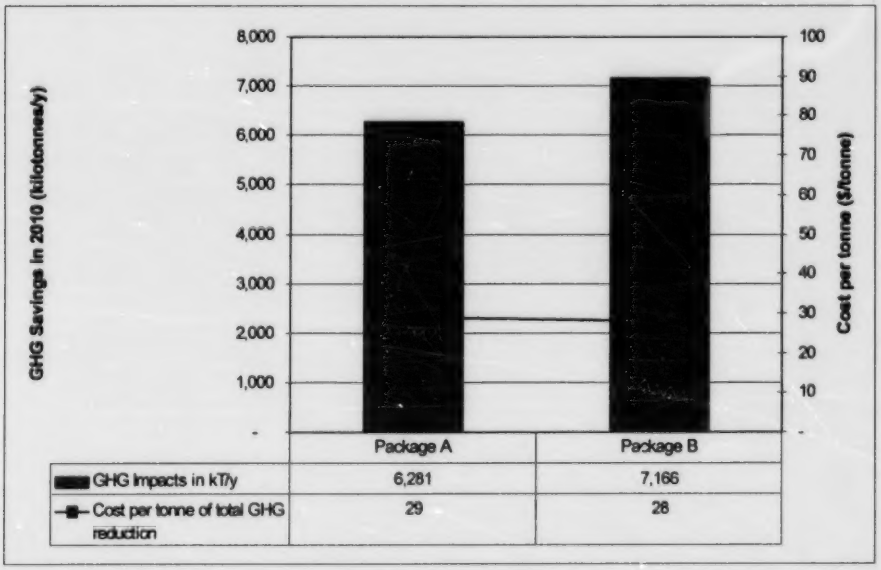
11.1 GHG IMPACTS AND COST PER TONNE

The two options Packages described in Section 10 were modelled for GHG impact and cost per tonne of GHG reduction.

The starting point for this analysis was the stand alone modelling results for the individual Measures. However, due to the interactive effects between Measures within an Options Package, several of the Measures' impacts need to be derated as a function of overlapping penetration rates. For example, Package A contains the Measures AE-1 (National Standards Program for Equipment and Appliances) and R-3 (National Energy Efficient Housing Renovation and Retrofit Program). Given that R-3 incorporates some of the same actions as AE-1, the Measures must be derated to avoid double-counting. Similarly, in Options Package B, Measures R-7V and R-7M (EnerGuide for Houses – Voluntary and Mandatory respectively) must be derated to eliminate overlap.

The modelling results for each package are presented in Figure 11.1. More detailed modelling outputs are provided for each package in Appendix C.

Figure 11.1
Comparison of GHG Impacts and Cost per Tonne for Residential Options Packages



11.2 DISCUSSION

Several key observations can be made from these results:

- The overall GHG impact of Package A is 13% less than the sum of GHG savings from the individual Measures it contains. For Package B, the GHG impact is 16% less than for the corresponding individual Measures. These modest reductions indicate that overlap between the Measures is relatively limited.

- Package A is largely dominated by two Measures, R-3 and AE-1, which account for about 70% of GHG impacts.

- Package B provides a 14% increase in GHG reduction over Package A. Although the additional Measures included in Package B are derated to account for interactive effects, their GHG impacts are still significant.

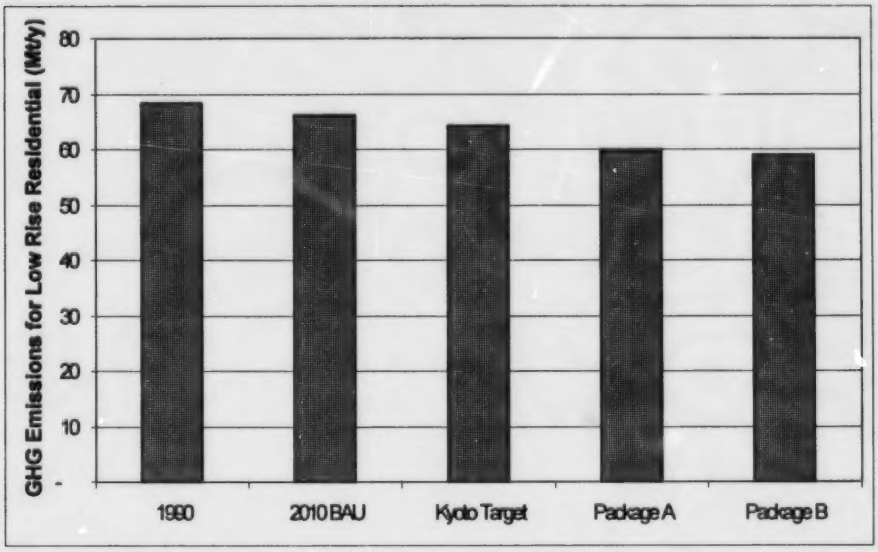
- The cost per tonne figures for the two packages are similar. This is not surprising, given that all Package A Measures are included in Package B, and that the combined cost per tonne for the additional Measures in Package B does not differ greatly from the cost per tonne of Options Package A.

In terms of a comparison with the Kyoto target, both Packages surpass the Kyoto GHG reduction target of 6% below 1990 levels. Package A, for instance, achieves a reduction that is more than 6% below the Kyoto target in 2010, as shown in Exhibit 11.1 and Figure 11.2.

Exhibit 11.1
Low Rise Residential GHG Emissions in 2010
(Mt CO_2 Equivalent)

	Kyoto	Package A	Package B
BAU low rise residential emissions (in 2010)	**66.2**	**66.2**	**66.2**
Emissions reduction	1.9	6.3	7.2
Net low rise residential emissions	64.3	59.9	59.0
RELATIVE TO 1990 68.4 Mt CO_2e @	-6.0%	-12.4%	-13.7%

Figure 11.2
Low-Rise Residential GHG Emissions
Relative to 2010 BAU and Kyoto Target



11.3 MID AND HIGH-RISE RESIDENTIAL (FOR INFORMATION PURPOSES ONLY)

GHG impacts and cost per tonne for the mid-rise and high-rise apartment segments were calculated as a part of the commercial buildings analysis, and are presented separately in the Options Paper for the commercial sector.

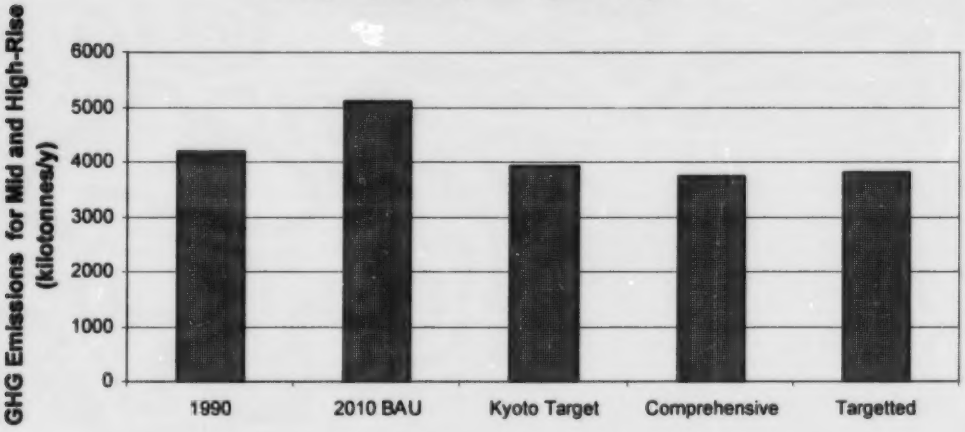
For information and comparison purposes, Exhibit 11.2 presents the GHG reduction impact of the commercial building Options Packages for these segments. As illustrated, the largest savings are related to indirect emissions (because the major GHG reduction opportunities are associated with end uses that depend primarily on electricity).

Figure 11.3 shows a comparison of the commercial measures impact on mid and high-rise apartments, relative to the 2010 BAU and Kyoto targets.

Exhibit 11.2
GHG Impact in 2010 of Commercial Measures on Mid-Rise and High-Rise Apartments

Commercial Sector Measure	GHG Impact in 2010 (kilotonnes)		
	Direct	Indirect	Total
Total for Comprehensive Options Package	354	1010	1364
Total for Targeted Options Package	336	959	1295

Figure 11.3
Comparison of Commercial Package GHG Reductions for Mid and High Rise Apartments Against Kyoto Target



12. ADDITIONAL WORK NEEDED

The analysis presented in the Options Paper is intended to provide initial information to assist in the screening and selection of broad options. As the Measures and Options Packages presented in this paper are developed further, much additional research will be required, particularly at the detailed design stage. This would include, for instance, more detailed costing, further assessment of costs and benefits, review of program design options, and dialogue with partners and other stakeholders.

While the Measures are conceived to be national in scope, the design will need also to include provision for regional adaptations, to take account of such factors as differing action and energy costs; age and characteristics of the housing stock; the needs of key stakeholders; and regional variation in the effectiveness of different delivery mechanisms.

Other issues of importance include the question of linkages at several levels:

- Some of the Measures presented in the residential and commercial sector *Options Reports* are similar in concept (for instance, Measures addressing efficiency of appliances and equipment). While it is appropriate to consider these Measures separately at this stage, opportunities for integration should be explored at the detailed program design stage.

- Linkage to the initiatives developed by other Issue Tables is also important. The buildings sector is interested in, and affected by, the work of diverse other sectors, including municipalities, transportation, public education and outreach, and more.

- There is also a need to review initiatives underway and under development in other jurisdictions. The goal should be to identify opportunities for co-ordinating Canada's approach to residential GHG emissions with approaches adopted elsewhere, where such co-ordination might improve effectiveness, reduce costs and avoid lost opportunities.

Various policy options that would be supportive of the recommended Measures may warrant further investigation. This could include, for instance, examination of the policy options that support community based approaches; review of the effectiveness of tradable permits as an alternative to more traditional policy approaches; and development of residential policies that might be adopted and applied by a municipality, in ways that contribute to GHG reductions.

The Measures and analysis presented here are focussed on the Kyoto targets for the years 2008-2012. Measures to address a longer time frame need also to be considered in the future. While the residential sector business-as-usual scenario shows a decline in greenhouse gas emissions leading up to 2010, emissions after that date are expected to grow significantly. This underlines the need for consideration of longer term efforts to control emissions.

Finally, it should be noted that the Table has focussed its efforts on the occupancy stage of the building life cycle, in recognition that this is the area where the vast majority of GHG reduction potential can be found.

However, other opportunities, such as the embodied energy in building materials, may warrant future consideration.

PART VI: RECOMMENDATIONS

13. OPTIONS PACKAGES

The Buildings Table offers the following majority recommendations with respect to the identified residential Options Packages:

Options Package A	
Recommendation:	**The Buildings Table recommends Options Package A as the minimum greenhouse gas reduction package for the low rise residential sector.**
Dissenting views:	The following table members have requested that their dissenting views be recorded: John Haysom (National Research Council), who does not support inclusion of R-3 (National Energy Efficient Housing Renovation and Retrofit Program) in the minimum Options Package; and the Canadian Home Builders' Association, who believe that Measures R-3 and AE-1 (National Standards Program for Equipment and Appliances) are problematic and require further development and analysis to enable realistic evaluation.
Commentary:	Options Package A enjoys substantial support among members of the Table, with dissenting views as noted above. Some Measures within Options Package A can proceed immediately; others will require additional developmental time.

Options Package B	
Recommendation:	**The Buildings Table did not reach agreement on a majority recommendation with respect to Options Package B.**
Commentary:	The additional Measures in Options Package B are supported by some members, but strongly opposed by others. All members agree that further development and analysis is required.

14. OTHER RECOMMENDATIONS

The Buildings Table offers the following additional recommendations relating to the implementation of the residential Options Packages:

Recommendation:	**Initiation of selected Measures within Options Package A should begin as soon as possible. The development process for the remaining Measures should also be initiated in the near term.**
Commentary:	The "easy" Measures in Options Package A provide an early opportunity to begin to reduce greenhouse gas emissions. In addition, several of the Measures in Options Package A provide a foundation for more effective implementation of other Measures. As such, early implementation is desirable. The implementation process for any new or expanded initiative is time consuming, requiring mobilization of partners; securing of resources; detailed design; and practical steps such as staffing, preparation of materials, and development of operational procedures. To ensure timely launch of the proposed Measures, the developmental process should begin early.

Recommendation:	**Although some Measures within Options Package A will be implemented before others, the Package should nonetheless be considered as a comprehensive program of initiatives. Any decision to select only a subset of the Package for implementation should be based on careful consideration of the linkages and complementarity between Measures.**
Commentary:	The Measures proposed provide broad coverage of the residential sector, and encompass a range of program types. This diversity helps to achieve maximum greenhouse gas reductions. Moreover, the program concepts underlying many of the Measures depend on, and support, several of the other Measures. These syneregies will be lost if changes to the Packages are implemented without careful consideration.

Recommendation:	**To provide a valid analytical support capacity and ensure minimal program monitoring requirements are met, it is recommended that appropriate data gathering and development activities be included as part of any Climate Change strategy and activity.**
Commentary:	Effective greenhouse gas reduction Measures will require effective monitoring of results achieved, and the analytical capacity to interpret and make use of the monitoring data.

APPENDIX A

- **Cost Assumptions**

INTRODUCTION

This Appendix presents the assumptions used in estimating the costs of the Measures described in this *Options Report.*

- **Exhibit A.1** lists the actions that have been used in the modelling of the various Measures, and the cost assumptions associated with these actions. Action cost estimates were previously presented in the report *Commercial/Institutional and Residential Sector Action/Opportunity Cost Curves*[1]. In subsequent deliberations of the Buildings Table, additional actions were added to the list, and some cost assumptions have been affected by changes in the business-as-usual scenario. Accordingly, an updated set of assumptions is presented in this Appendix.

- **Exhibit A.2** lists the assumptions concerning costs of program implementation for each of the Measures (organized by Category). The costs referred to in this Exhibit are distinct from the action costs, and include administrative costs and any incentive that may be offered as a part of the Measure. It must be stressed that these costs of program implementation are intended to be indicative only, to assist in the initial assessment of Measures. Actual costs of the Measures will only be determined at the detailed program design stage.

[1] Marbek Resource Consultants, in association with Sheltair Scientific, and SAR Engineering (April 1999).

Exhibit A.1
Residential Sector Actions

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
New Construction				
N1 Upgraded Model Energy Code for Houses	• Upgrade energy performance levels of new buildings to requirements of a new two stage Model National Energy Code for Houses (MNECH). • First Stage- 2003 to 2006 - Improvement in thermal performance equal to half that achieved in the second stage MNECH (see below). This results in an improvement in thermal performance of ~11% over current MNECH. • Second Stage - 2007 to 2010 -Upgraded MNECH using an environmental multiplier of 1.5. This results in an improvement in thermal performance of ~22%over current MNECH. • Acton costs are based on estimates of incremental costs of MNECH in the Maritimes, plus additional costs due to individual differences by province. In Quebec, Ontario, Manitoba, Saskatchewan, and Alberta a cost is added for HRV's for the portion of new stock that is not installing HRV's under the business as usual scenario, plus an additional incremental cost for ductwork required for HRV's in the non-forced air heated portion of stock. In BC it is assumed that the new MNECH codes would only require HRV's in the electrically heated stock (as is the case with the current MNECH). Thus the cost of HRV's are only added to this portion of the stock. However, additional costs are added to BC new housing costs over other provinces for window and air sealing upgrades. The cost of OTC controllers is also included for all provinces. • Action costs shown are incremental cost for an average size new unit. Actual unit size varies by region.	Incr. Cost for 225 m^2 house (example) First Stage: E Coast-$813 Quebec-$2013 Central-$1608 W Coast-$1539 Second Stage: E Coast-$1673 Quebec-$2873 Central-$2468 W Coast-$2264	Incr. Cost for 183 m^2 unit (example) First Stage: E Coast-$661 Quebec-$1637 Central-$1308 W Coast-$1251 Second Stage: E Coast-$1361 Quebec-$2337 Central-$2007 W Coast-$1841	Incr. Cost for 96 m^2 unit (example) First Stage: E Coast-$347 Quebec-$859 Central-$686 W Coast-$656 Second Stage: E Coast-$714 Quebec-$1226 Central-$1053 W Coast-$966

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
N2 R2000 Standard	• Upgrade energy performance levels of new buildings to requirements of a two stage R2000 standard. • First Stage- 2000 to 2005 -Current R2000 Standard • Second Stage - 2006 to 2010 - Updated R2000 Standard resulting in an improvement in thermal performance of 10% over current R2000 Standard. • Acton costs are based on current R2000 incremental costs, using a ratio of thermal performance achieved to thermal performance improvements of current R2000, taking into account business as usual thermal performance improvements of 5% by 2010. • R2000 cost variance by region is due to differences in business as usual penetration rates of HRV's, and performance of windows, insulation and other building construction methods.	Incr. Cost of 225 m^2 house: First Stage: E Coast-$3513 Central-$5625 W Coast-$7737 Second Stage: E Coast-$4231 Central-$6773 W Coast-$9316	Incr. Cost of 183 m^2 unit: First Stage: E Coast-$2858 Central-$4573 W Coast-$6293 Second Stage: E Coast-$3441 Central-$5509 W Coast-$7577	Incr. Cost of 96 m^2 unit: First Stage: E Coast-$1500 Central-$2400 W Coast-$3300 Second Stage: E Coast-$1805 Central-$2890 W Coast-$3975
N3 High Efficiency Gas Furnaces and Boilers	• Upgrade gas furnaces and boilers in new buildings to high efficiency.	$900	$900	$1000
N4 High Efficiency Oil Furnaces and Boilers	• Upgrade oil furnaces and boilers in new buildings to high efficiency.	$900	$900	$1000
N5 Integrated High Efficiency Gas Space Heat/DHW	• Upgrade to high efficiency integrated gas space heating and hot water boilers in new gas heated buildings.	$2,000	$2,000	$1,100
N6 Integrated High Efficiency Oil Space Heat/DHW	• Upgrade to high efficiency integrated oil space heating and hot water boilers in new oil heated buildings.	$2,000	$2,000	$1,100
N7 Air Source Heat Pumps	• Upgrade to air source heat pumps in new central electrically heated buildings.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
N8 Ground Source Heat Pumps	• Upgrade to ground source heat pumps in new central electrically heated buildings.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
N9 Air Source Heat Pumps with DHW	• Upgrade to air source heat pumps with integrated DHW in new central electrically heated buildings.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
N10 Ground Source Heat Pumps with DHW	• Upgrade to ground source heat pumps with integrated DHW in new central electrically heated buildings.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
N11 Window Upgrade	• Upgrade window R value by 30% in new construction.	$25/m2	$25/m2	$25/m2
N12 Improved Appliances, Lighting, and Motors	• Upgrade to energy efficient appliances, lighting, and motors at incremental cost in new buildings. • This action is modelled as an overall 20% reduction in electrical consumption over business as usual assumptions, from all electrical equipment - major appliances, lighting, furnace and ventilation motors, minor appliances. • Business as usual assumes an average energy use per household for all major appliances decreasing from 4,478 kWh/y in 1998 to 3,209 kWh/y in 2010 (28% reduction), plus average energy use per household for minor appliances increasing from 1300 kWh/y in 1998 to 1500 kWh/y in 2010 (15% increase), for a net 19% reduction from 1998 to 2010 for all appliances on a per household basis. • The 20% reduction below business as usual could be achieved from a wide range of options, estimated being achieved at an incremental cost of $450 to $800 per unit.	$500 used in Measure AE-1 $800 used in Measures AE-5, AE-6	$450 used in Measure AE-1 $720 used in Measures AE-5, AE-6	$500 used in Measure AE-1 $800 used in Measures AE-5, AE-6
N12a Improved HRVs	• Upgrade to more energy efficient HRVs (Premium Energy Performance) at incremental cost relative to BAU, which is a regionally dependant mix of fans and HRVs	Varies by region ($950 to $1400)	Varies by region ($950 to $1400)	Varies by region ($950 to $1400)
N13 Solar Hot Water Heaters	• Install solar hot water heaters on new buildings at full cost.	$3,000	$2,835	$1,836
N14 OTC Ventilation Controller	• Add ventilation control to shut off continuous ventilation systems when outdoor temperature will result in overall air change in excess of 0.3 ACH	$230	$230	$230

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
N15 Photovoltaic Panels	• Install 2 kW grid connected PV systems on new buildings at full cost.	$14,700	$14,700	$14,700
N16 Increased Insulation	• Increase insulation by 10% above MNECH levels at incremental cost	Varies by Region and Building Size	Varies by Region and Building Size	Varies by Region and Building Size
RETROFIT OF EXISTING STOCK				
E1a House as a System Retrofit Bundle @ Incremental Cost	• Insulate walls, ceilings, overhanging floors, and foundations to approximately current MNECH performance levels • Upgrade doors to RSI 1.4 & windows to approx current MNECH levels. • Air seal, increase ventilation rates to a minimum of 0.3 ac/hr, add ventilation heat recovery and ventilation controllers.	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage
E1b House as a System Retrofit Bundle @ Full Cost	• Same assumptions as E1a except capital costs assume the full cost of retrofit actions.	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage
E1c House as a System High Level Retrofit Bundle @ Incremental Cost	• Same assumptions as E1a, except insulation levels increase to approximately 30% above current MNECH, and Energy Rating for windows increases to an average ER 6 above MNECH.	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage
E2a Window Replacement @ Incremental Cost	• Upgrade windows to approximately MNECH levels at incremental cost during building renovation.	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage
E2b Window Replacement @ Full Cost	• Upgrade windows to approximately MNECH levels at full cost during building retrofit.	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage	Costed in REES - varies by region and vintage

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
E3a High Efficiency Gas Furnaces and Boilers @ Incremental Cost	• Upgrade gas furnaces and boilers to high efficiency during natural equipment turnover at incremental cost.	$900	$900	$1000
E3b High Efficiency Gas Furnaces and Boilers @ Full Cost	• Upgrade gas furnaces and boilers to high efficiency prior to natural turnover at full cost.	$3100	$3100	$1670
E4a High Efficiency Oil Furnaces and Boilers @ Incremental Cost	• Upgrade oil furnaces and boilers to high efficiency during natural equipment turnover at incremental cost.	$900	$900	$1000
E4b High Efficiency Oil Furnaces and Boilers @ Full Cost	• Upgrade oil furnaces and boilers to high efficiency prior to natural turnover at full cost.	$3100	$3100	$1670
E5a Integrated High Efficiency Gas Space Heat/DHW @ Incremental Cost	• Replace gas furnaces and boilers with high efficiency integrated space heating/DHW gas boilers during natural equipment turnover at incremental cost.	$2000	$2000	$1100
E5b Integrated High Efficiency Gas Space Heat/DHW @ Full Cost	• Replace gas furnaces and boilers with high efficiency integrated space heating/DHW gas boilers prior to natural turnover at full cost	$5000	$5000	$1900
E6a Integrated High Efficiency Oil Space Heat/DHW @ Incremental Cost	• Replace oil furnaces and boilers with high efficiency integrated space heating/DHW oil boilers during natural equipment turnover at incremental cost.	$2000	$2000	$1100

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
E6b Integrated High Efficiency Oil Space Heat/DHW @ Full Cost	• Replace oil furnaces and boilers with high efficiency integrated space heating/DHW oil boilers prior to natural turnover at full cost.	$5000	$5000	$1900
E7a Air Source Heat Pumps @ Incremental Cost	• Install air source heat pumps in all existing central electrically heated buildings during natural equipment turnover at incremental cost.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E7b Air Source Heat Pumps @Full Cost	• Install air source heat pumps in all existing central electrically heated buildings prior to natural equipment turnover at full cost.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E8a Ground Source Heat Pumps @ Incremental Cost	• Install ground source heat pumps in existing central electrically heated buildings during natural equipment turnover at incremental cost .	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E8b Ground Source Heat Pumps @Full Cost	• Install ground source heat pumps in existing central electrically heated buildings prior to natural equipment turnover at full cost .	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E9a Air Source Heat Pumps with DHW @ Incremental Cost	• Install air source heat pumps with integrated DHW in existing central electrically heated buildings during natural equipment turnover at incremental cost..	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E9b Air Source Heat Pumps With DHW @Full Cost	• Install air source heat pumps with integrated DHW in existing central electrically heated buildings prior to natural equipment turnover, at full cost.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E10a Ground Source Heat Pumps with DHW @ Incremental Cost	• Install ground source heat pumps with integrated DHW in existing central electrically heated buildings during natural equipment turnover at incremental cost.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
E10b Ground Source Heat Pumps With DHW @Full Cost	• Install ground source heat pumps with integrated DHW in existing central electrically heated buildings prior to natural equipment turnover, at full cost.	Varies by Heat Load	Varies by Heat Load	Varies by Heat Load
E11 Improved HVAC System Sizing and Installation	• Improved sizing and installation of heating equipment in existing gas and oil heated stock during natural turnover.	$150	$150	$150
E12 Reduced Hot Water Demand	• Install water reducing sink and shower fixtures, and hot water efficient appliances, that result in a total hot water demand reduction of 20% per dwelling	$400	$360	$272
E13 Improved Appliances, Lighting, and Motors	• Upgrade to energy efficient appliances, lighting, and motors at incremental cost in the existing stock during natural turnover of equipment. • This action is modelled as an overall 20% reduction in electrical consumption over business as usual assumptions, from all electrical equipment that is replaced during natural turnover - major appliances, lighting, furnace and ventilation motors, minor appliances. • Business as usual assumes an average energy use per household for all major appliances decreasing from 4,478 kWh/y in 1998 to 3,209 kWh/y in 2010 (28% reduction), plus average energy use per household for minor appliances increasing from 1300 kWh/y in 1998 to 1500 kWh/y in 2010 (15% increase), for a net 19% reduction form 1998 to 2010 for all appliances on a per household basis. • The 20% reduction below business as usual could be achieved from a wide range of options, estimated being achieved at an incremental cost of $450 to $800 per unit.	$500 used in Measure AE-1 $800 used in Measures AE-5, AE-6, R-3, and R-6B	$450 used in Measure AE-1 $720 used in Measures AE-5, AE-6, R-3, and R-6B	$500 used in Measure AE-1 $800 used in Measures AE-5, AE-6, R-3, and R-6B
E13a Improved HRVs	• Upgrade to more energy efficient HRVs (Premium Energy Performance) at incremental cost relative to a regionally dependant mix of fans and HRVs	Varies by region ($950 to $1400)	Varies by region ($950 to $1400)	Varies by region ($950 to $1400)
E14 Solar Hot Water Heaters	• Install solar hot water heaters in existing buildings at full cost.	$3,000	$2,835	$1,836

Action	Description	Capital Cost Per Dwelling Unit		
		Single Detached	Attached	Low Rise Apartment
E15 Photovoltaic Panels	• Install 2 kW grid connected PV systems on existing buildings at full cost.	$14,700	$14,700	$14,700

Exhibit A.2
Assumptions Concerning Costs of Program Implementation – Residential Sector

Note: The costs provided in the Measure Profiles represent the net present value of the estimates presented below (except as noted).

Measure		Assumptions concerning costs of program implementation
MEASURES INCLUDED IN OPTIONS PACKAGES A AND B		
R-3	National Energy Efficient Housing Renovation and Retrofit Program	*Administrative and related costs* based on Green Communities and utility DSM program experience using the following assumptions: • Green Communities Program costs of $250 per participating dwelling unit. • 80% of units carry out some action, 20% of those carry out major actions similar to those modeled in R-3 Measure; therefore program cost = $312.5/.8/.2=$1562.5 per unit. • Average homeowner investment in major retrofits = $5000 of full cost of actions. Net program costs = 31% of full cost of major actions. • Double number of units carrying out major retrofits to take into account effect of minor actions, economy of scale effects, and additional market barrier removal components of R-3 program (tax breaks, Energuide for Houses, retrofit guidelines, and builder and sales training components). • Therefore program cost of 23.3% of R-3 action costs (taking into account R3's mix between incremental and full cost actions). • Add cost of retrofit guidelines, Voluntary Energuide for Houses, Builder and Retail Training (Program costs of $18.8 million present value over ten years). *Cost of Incentive:* HST, PST, and GST tax breaks based on an average of 14% of full cost of actions, except for house as a system actions in which subsidies are calculated on incremental cost (corrected to remove the cost of labour in the case of insulation). Add costs of $40.6M present value over ten years from Voluntary Energuide for Houses *Program Start and Duration:* 11 years starting in 2000
AE-1	National Standards Program for Equipment and Appliances	*Administrative and related costs* based on estimates from NRCan OEE: • $2M/year for more intensive residential equipment regulation program (current budget is $1M for both commercial & residential) • $2M/year for window standards/ transformation program. *Cost of Incentive*: No Incentive *Program Start and Duration*: 7 years starting in 2004

Measure	Assumptions concerning costs of program implementation
AE-5 Premium Energy Performance Labelling Program for Equipment and Appliances	*Administrative and related costs* based on estimates from NRCan OEE: • $2M/year for Premium Energy Performance Labelling Program. Based on $50M/year cost for US Energy Star Program (in both residential and commercial sectors), extrapolated to Canadian population ($5M/year), reduced to $4M/year assuming taking advantage of US development experience, ½ of $4M/year is assumed to be the residential portion. • Costs allocated between federal gov, provincial governments, equipment manufacturers, and other partners. *Cost of Incentive*: No Incentive *Program Start and Duration*: 10 years starting in 2001
AE-8 Equipment Leasing Facilitation Program	*Administrative and related costs*: • Assume $1 of program costs to $75 action costs leveraged based on cost effective end of DSM program cost range. *Cost of Incentive*: No Incentive *Program Start and Duration*: 10 years starting in 2001
R-7V Energuide for Houses Program– Voluntary	*Administrative and related costs* based on current Energuide Program experience: • $1.635M/year program costs based on expanded current Energuide for Houses program administration costs. *Cost of Audits*: $6M/year based on 40,000 houses per year at $150 per house. *Cost of Incentive*: No Incentive (This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.) *Program Start and Duration*: 10 years starting in 2001
R-6B R-2000 for Existing Dwellings Renovation Program	*Administrative and related costs*: • Program costs calculated using same ratios as R-3 *Cost of Incentive*: HST, PST, and GST tax breaks based on an average of 14% of full cost of actions, except for house as a system actions in which subsidies are calculated on incremental cost (corrected to remove the cost of labour in the case of insulation). *Program Start and Duration*: 9 years starting in 2002

Measure	Assumptions concerning costs of program implementation
R-5A Strengthened R-2000 Program	*Administrative and related costs* based on estimates from NRCan OEE: • NRCan projected costs of $3.2 M/year for an expanded R2000 program that would achieve a 2% certified R2000 home penetration rate. • Additional $6.4 M/year for increased marketing and builder training, to increase penetration rate of certified R2000 homes and encourage distribution of R2000 technology into the market. *Cost of Incentive*: No Incentive *Program Start and Duration*: • 11 years starting in 2000 • Stage 1 runs from 2000 to 2005 and is based on current R2000 Standard with penetration rate ramped up to full level during first 5 years. • Stage 2 is an updated R2000 Standard running from 2006 to 2010.
R-1A Assisted Housing Program	*Administrative and related costs:* • Program costs of 1.33% of action costs based on current program costs of Federal Buildings Initiative Program which leverages $75 in action costs for $1 in program costs. *Cost of Incentive*: No Incentive (However action costs are incurred by government in federally and provincially supported subsidized housing). *Program Start and Duration*: 11 years starting in 2000
R-1B Low Income Housing Program	*Administrative and related costs*: • Program costs of 8% of action costs based on utility financing program cost experience in residential sector. *Cost of Incentive*: 20% of action costs *Program Start and Duration*: 11 years starting in 2000
R-6A Housing Energy Technology Demonstration Program	*Administrative and related costs* based on estimates from NRCan OEE: • $2.0M/year federal government program costs • $8M/year leveraged from industry • Program would demonstrate a number of products in detached, attached, and apartment sectors (integrated space/DHW, renewable energy technologies, apartment fireplace integrated systems, apartment metering etc). Includes both longer term risky products and short term non risky. *Cost of Incentive*: No Incentive (This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.) *Program Start and Duration*: 10 years starting in 2001

Measure	Assumptions concerning costs of program implementation
AE-4 Technology Commercialization Program	*Administrative and related costs* based on estimates from NRCan OEE. • $2.0M/year federal government program costs • $8M/year leveraged from industry • Based on current commercialisation program being developed that includes integrated space heat/DHW and ventilation system (HRV) commercialisation. Assume other technologies included in future years of a 10 year program. *Cost of Incentive*: No Incentive (This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.) *Program Start and Duration*: 10 years starting in 2001
R-10 Residential Retrofit Guidelines and Installation Standards	*Administrative and related costs* based on estimates from NRCan OEE: • $200,000 to develop retrofit guidelines • $200,000 to implement training and certification programs in first year • $100,000 per year administration costs after first year *Cost of Incentive*: No Incentive *Program Start and Duration*: 10 years starting in 2001

Measure	Assumptions concerning costs of program implementation
ADDITIONAL MEASURES INCLUDED IN OPTIONS PACKAGE B	
R-4A Adoption of More Stringent MNECH by Provinces	*Administrative and related costs* based on estimates from NRCan OEE: • $500,000 per year for promotion • $100,000 per year at federal level for one person and administration costs • $500,000 per year for ½ person per province to administer code • $250,000 per year for increased municipal costs in jurisdictions that do not already regulate energy in new housing • Total = $1.35M/year • One time cost to revise MNECH = $500,000 to redo LCC runs, software, and rewrite code *Cost of Incentive*: No Incentive *Program Start and Duration*: 8 years starting in 2003; Stage 1 runs from 2003 to 2006; Stage 2 runs from 2007 to 2010.
R-7M Energuide for Houses Program– Mandatory	*Administrative and related costs* based on current Energuide Program experience: • $3.27M/year program costs assuming doubling of voluntary program costs. *Cost of Audits*: $60M/year based on 100,000 new houses per year plus 300,000 existing house sales at $150/house. *Cost of Incentive*: No Incentive (This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.) *Program Start and Duration*: 8 years starting in 2003
AE-6 Reduced Sales Taxes to Encourage Purchase of EE Products in New Construction	*Administrative and related costs*: • Assume $1 of program costs to $35-40 action costs leveraged based on cost effective end of DSM program cost range. *Cost of Incentive*: HST, PST, and GST tax breaks based on an average of 14% of full cost of actions. For insulation, incentive based on full cost of insulation in qualifying houses, which was calculated using annual insulation sales in new construction of $254 million x pentration rate for this action (insulation sales data from Owens Corning). *Program Start and Duration*: 10 years starting in 2001
OTHER MEASURES THAT MERIT CONSIDERATION	
R-11 Building Permit Feebates	*Administrative and related costs*: • Not costed - This measure is being handled by the Municipalities Table. *Cost of Incentive*: No Incentive *Program Start and Duration:* 8 years starting in 2003

APPENDIX B

- **Measure Profiles**

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INTRODUCTION

Appendix B presents the detailed Measure Profiles for each of the Measures under consideration, as developed by the Marbek/SAR/Sheltair team.[1] The Measure Profiles are presented in the same order as the Measures appear in the main text. Each Profile consists of three parts:

1. **Overview Template**, which describes the Measure and its impacts

2. **Measure Data Sheet**, which provides the detailed modelling results for the Measure

3. **Other Impact Assessment Sheet,** which describes economic, social, health and environmental impacts associated with the Measure.

Each of these parts of the Measure Profiles are described below.

Overview Template

Each Measure Profile begins with a two page (approximately) text description of the Measure. For each Measure, the following information is provided:

- **Description of Measure,** including a general narrative description, type of measure, time frame, target subsector and stakeholder groups, responsibility, and relationship to other measures.

- **Summary of greenhouse gas impact** in the year 2010, both direct (i.e. emissions on-site) and indirect (associated with electricity use, with emissions at the point of generation)

- **Summary of other impacts** based on available information, in such areas as economic, social, environmental, and health impacts (further detail is provided in the Other Impacts Assessment Sheets described below)

- **Costs and funding,** including program related costs to the year 2010, and possible funding options

- **Other information** relating to the Measure

- **Recommendations** of the Buildings Table, including convergence/divergence of stakeholder views concerning the Measure.

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[1] Source of data is *Commercial/Institutional and Residential Sector Measures Development and Analysis,* Marbek Resource Consultants, Sheltair Scientific, and SAR Engineering (August 1999).

Measure Data Sheet

The Measure Data Sheet for each Measure provides details on the actions modelled within the Measure; penetration rates assumed; GHG impacts nationally, by segment, and by province; and costs per tonne of greenhouse gas reduction nationally, and where possible by segment and by province. For Measures that are primarily "enabling" in nature, the Data Sheet identifies the multiplier and affected Measures used to estimate impact.[2]

All results are based on the marginal natural gas scenario. Costs and savings are calculated using a discount rate of 10%. All amounts are expressed in 1999 dollars. Cost per tonne of GHG reduction is presented based on total GHG reductions generated by the Measure (cost per tonne based on GHG reductions in the year 2010 is also presented in Section 9 of the main report).

Other Impacts Assessment Sheet

The Other Impact Assessment Sheets present identified non-energy impacts of the Measures. The principal objective of the non-energy assessment is to identify any related impacts, either positive or negative, that could significantly influence the overall ranking/desirability of the specific Measures. This non-energy impact assessment, therefore, represents an additional screening step in the development and final selection of the preferred residential Measures.

In parallel with this current study, CMHC commissioned a separate study that addressed certain economic and social impacts of the Measures. This study was completed by Greg Lampert and Steve Pomeroy (Focus Consulting). The results of this study have been made available for inclusion in this Options Report. Specifically, the Lampert/Pomeroy study has contributed inputs to the economic and social impact portions of the Assessment Sheets.

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[2] For any given enabling Measure, the list of affected Measures provided in the Overview Template may not match the multipliers list in the Data Sheets. This difference reflects the fact that multipliers are not necessarily applied to all affected Measures, because in certain cases this would result in double counting.

MEASURES INCLUDED IN OPTIONS PACKAGES A & B

R-3: NATIONAL ENERGY EFFICIENT HOUSING RENOVATION AND RETROFIT PROGRAM

DESCRIPTION OF MEASURE

General description:

This Measure is designed as a comprehensive and integrated initiative to encourage consumers to upgrade the efficiency of existing homes.

The Measure would include: incentives to retrofit/renovate (tax breaks such as removal of GST, PST, HST, and/or accelerated depreciation of costs in rental housing); access to financing (including "green mortgages"); home energy audits and labelling (Energuide for Houses); renovator training/certification; a retail element including sales force training; accelerated equipment replacement component; and involvement of community based delivery agents (e.g., Green Communities).

A significant feature of this Measure is the proposed incentive to retrofit. This incentive could in principle take various forms, but is conceived as a tax reduction. This aspect of Measure R-3 is patterned after Measure AE-6, and would be fully coordinated with AE-6 if both Measures are implemented. The tax reduction would apply to energy efficient equipment, appliances, and windows, as well as to insulation. As with AE-6, certain performance levels would be required before participants qualify for the reduction. It is anticipated that the comprehensive support services associated with R-3 will ensure targeting of retrofit activity, yielding greater GHG impact.

Implementation of this Measure should be guided by broad experience that has been gained in the delivery of energy retrofit services. Consideration should be given to the program framework developed for the Public Education and Outreach Issue Table, which includes home audit, financing, and quality assurance elements.[3]

This Measure is targeted at all low-rise residential segments – detached, attached, and low-rise apartments. At the detailed design stage, it may be appropriate to consider whether the low-rise apartments are best served through this Measure, or through a similar commercial sector Measure directed at mid- and high-rise apartments. Consideration of the unique needs of rental housing will also be important at the design stage.

The actions included as part of this measure are listed in the attached Measure Data Sheet.

Type of measure:	Multi-faceted
Time frame:	11 years starting in 2000
Target subsector:	Existing low rise residential
Target stakeholder group:	Building owners; home owners; facility managers; tenants
Responsibility:	Federal government, provinces, municipalities, industry (including renovators, building and equipment suppliers, ESCOs, financial institutions), utilities. Key to successful implementation will be full involvement of industry as partners in delivery.

[3] *Community-based Home Energy/Environmental Audit Evaluation Report*, prepared for the PEO Issue Table by Enviros-RIS, March 1999.

Relationship to other measures:	This program encompasses several other enabling measures including R-10 Residential Retrofit Guidelines and Installation Standards, and R-7V Energuide for Houses.[4] The program is also supported by AE-1 and AE-6, and by several additional enabling measures (R-6A, AE-4, and AE-8). This Measure would also need to be coordinated with, and support, R-6B, R-1A and R-1B. The program should also link with other related initiatives proposed by other tables (e.g. revolving fund concept under consideration by the Municipalities Table).

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **3,140 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for retrofit, renovation, and equipment replacement scenarios. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

Overall, this Measure provides strongly positive environment and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions associated with this Measure contribute to smog reduction and provide respiratory and related health benefits. Building envelope improvements demand proper installation and operation of ventilation systems to ensure that indoor air quality is maintained.

Industry is positively affected through increased renovation activity and increased demand for related EE products. In the short term, no significant effects are expected on homeowners' or renters' ability to afford housing. For the typical house modelled, however, first year amortized construction costs (based on a 10-year amortization period) significantly exceed first year energy savings. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$5,530 million.** The cost of the incentive anticipated by this program as currently described is estimated to be **$800 million.**[5] The administrative and related costs are estimated to be **$1,330 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated to exceed **$3,010 million** over the life of the actions stimulated by the measure.

[4] These enabling Measures are intended to be fully incorporated into Measure R-3, and as a result the modelling of R-3 is based on full integration. To avoid double counting, costs and savings associated with R-3 should not be added to the "stand alone" estimates presented elsewhere for the specified enabling Measures.

[5] The incentive offsets the cost of the action from the point of view of the participant, but does not affect the actual cost of the action per se. In other words, the cost of the incentive cannot be added to the other costs when determining the total cost of the Measure. However, the cost of the incentive does affect the cost of the Measure to the organization responsible for implementation of the Measure.

Source of funds	The cost of the incentive would be incurred by the governments providing relief from GST/PST/HST. Other costs of program implementation would be provided by the federal and provincial governments according to a cost sharing formula to be determined. Industry (including utilities) and municipal sponsorship would be sought, and partial cost recovery from users and suppliers should be explored as an option.

OTHER INFORMATION

Positive Toronto experience with retrofit programming supports the concept of municipal involvement. Some actions would occur at lower cost (do-it-yourself); this has not been included in the modelling. Actions E1a and E1b (House as a System Retrofit Bundle) provide a comprehensive approach to envelope retrofit. While a goal of this Measure is to encourage and assist homeowners to adopt a comprehensive approach, it is likely that many will not undertake the full retrofit bundle. The penetration rates selected for this action are intended to account for this variability.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

CHBA does not support inclusion of this Measure due to concerns with the incentive element, and associated problems with free ridership.

John Haysom agrees that the potential for greenhouse gas reduction in the existing housing stock is very large, and that efforts should be made to tap this potential. However, he is concerned that this Measure, as described, does not adequately convey the difficulties that are likely to be encountered in pursuing these reductions. The remaining opportunities include a high proportion of more technically difficult retrofits, and of building owners who have not participated in previous retrofit initiatives. Without technical or marketing breakthroughs, the large investment in this Measure may not produce the desired results. It is his view, therefore, that the residential sector GHG reduction initiatives should not rely excessively on this Measure.

OTHER IMPACTS - MEASURE R-3: National Energy Efficient Housing Renovation & Retrofit Program and R-6B R-2000 for Existing Dwellings Renovation Program

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Housing price/rent	Capital cost impact of measure	• Increased spending on renovation/retrofits may be reflected in higher values of housing – could reduce affordability for first time buyers, though partially offset by lower operating costs
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• No significant impact on existing residents. This is a voluntary measure so increased spending by homeowners will come from available disposable income. For renters, unlikely that costs would lead to higher market rents.
	Housing Industry Impacts	Impact on industry activity	• Increased housing industry activity through higher levels of EE renovations/retrofits • Estimates of costs and savings resulting from the measure indicate that substantial incentives would be required to encourage most owners to participate
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products from higher levels of EE renovations/retrofits – related benefits in terms of increased employment
	Competitiveness	Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Employment	Net jobs created or lost	• Increased employment levels
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
		Related impacts on ozone depleting substances	• Potentially increased emissions of ozone depleting substances from increased use of heat pumps and early retirement of air conditioning and refrigeration equipment
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of condensate
	Terrestrial Effects	Related effects on levels of material consumption	• Increased building material consumption from increased rate of envelope and equipment retrofits, leading to negative ambient air quality, aquatic and terrestrial impacts
		Related effects on disposal of materials	• Increased disposal of building materials leading to landfill impacts • Increased disposal of toxic materials due to production and disposal of PV panels

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
		Other	• Decreased damage to crops and plants from reduced emission of air pollutants from combustion of fossil fuels on site for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of chronic respiratory disease and reduced respiratory function
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise due to improvements to building envelope
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• Increased risk of falling accidents from maintenance of residential solar DHW and PV systems
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

AE-1: NATIONAL STANDARDS PROGRAM FOR EQUIPMENT AND APPLIANCES

DESCRIPTION OF MEASURE

General description:

This Measure involves minimum efficiency standards and Energuide labelling for a range of products, with new standards introduced in 2004. Products to be addressed by this measure would include, as a minimum:

- HVAC equipment (including HRVs)
- Major appliances
- Domestic water heaters
- Lighting
- Windows and doors
- Motors
- Gas fireplaces.

This Measure is directed at the manufacture and sale of the affected products. It directly affects the efficiency of the products available in the marketplace, with the goal of eliminating the least efficient products. This measure does not depend on building codes or similar mechanisms, but coordination of federal and provincial energy efficiency acts would be required.

The design of the Measure would need to allow for future development of products, with respect to the minimum standards. The minimum efficiency levels would need to be set based on assessment of available technological choices, and life cycle cost considerations.

The specific products modelled are listed in the Measure Data Sheet. For major appliances, lighting, motors, and other electrical equipment, it has been assumed in modelling this Measure that the minimum standards provide a 20% improvement in the energy intensity assumed in the business-as-usual scenario (with particular emphasis on motors).

Note that the penetration rate listed in the Measure Data Sheets for HE gas furnaces includes the post 2005 period. However, no costs or savings are generated by HE gas furnaces within this Measure, because these furnaces are included in the BAU.

Type of measure:	Regulation
Time frame:	7 years starting 2004 (2005 for gas furnaces, as assumed in the business as usual scenario)
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Equipment manufacturers/distributors; retailers; building owners; home owners
Responsibility:	NRCan, provinces, manufacturers, utilities
Relationship to other measures:	This Measure will have significant interaction with most other Measures. These interactions need to be considered in the analysis of combinations of Measures.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **2,000 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.

Summary of market penetration	This measure was modelled for an equipment replacement scenario, and for new housing. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

Analysis of construction costs and potential savings for a typical new house indicates that the net cost of this measure is in the range of $2,200 for an oil heated home, or $1300 for gas. This would increase the cost of new housing and have follow-on effects on new and resale housing prices, and on affordability.

Overall, this Measure provides positive environment and health impacts with no significant anticipated social impacts. Improved appliance and equipment efficiency results in fewer local emissions with corresponding improvements to ambient air quality and related respiratory health benefits. Reduced electricity demand also contributes to reduced non-GHG emissions at the point of generation.

Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$2,060 million.** The administrative and related costs are estimated to be **$15 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$1,640 million** over the life of the actions stimulated by the measure.
Source of funds	Funding for this initiative would be provided by the federal government (funding must come from a neutral party).

OTHER INFORMATION

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

CHBA does not support this Measure. HRAI expresses reservations with respect to inclusion of HE gas furnaces in the business-as-usual scenario, as described previously in Section 4.6.

The Building Professionals Consortium does not agree with the analysis of affordability impacts (see detailed comments in Measure R-4A).

OTHER IMPACTS ASSESSMENT SHEET: AE-1 National Standards Program for Equipment & Appliances

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
Economic	Housing price/rent	Capital cost impact of measure	• Analysis of construction costs and potential savings for typical new house indicates that the incremental cost of this measure is in the range of $2,200 for an oil heated home, or $1300 for gas. This would increase the cost of new housing. (The different costs occur because high efficiency gas furnaces are included in the business-as-usual scenario, and thus are not included in this Measure.)
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• Initial estimates indicated that the increase in energy standards would have an impact on affordability, estimated at 7,000 to 14,000 fewer first time buyers able to afford a starter home. Changes to the Measure to fully remove gas furnaces would reduce the impact of this Measure on affordability; however, revised estimates are not available.
		Consumer choice	• Consumer choice could be reduced, depending on extent of price increase vs. utility savings
	Housing Industry Impacts	Impact on builder margins	• Increase in construction costs for new housing may not be fully reflected in higher prices for some period, due to competition from existing stock - would then squeeze builders' margins • Ultimately, the higher costs would likely result in a similar price increase
		Change in demand for related products & equipment and effects on Canadian suppliers	• Unlikely to be significant unless substantial increases in costs – which would tend to reduce overall demand for equipment • Would be negative for manufacturers unable to meet new standards
	Competitiveness	Export opportunities	• Increase efficiencies in development and manufacture of EE products could lead to improved exports
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
		Related impacts on ozone depleting substances	• Potentially increased emissions of ozone depleting substances from early retirement of air conditioning and refrigeration equipment
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of condensate
	Terrestrial Effects	Related effect on disposal of materials	• Potentially increased disposal of materials due to early retirement of equipment

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
		Other	• Decreased damage to crops, forests, other plants and buildings from reduced emission of air pollutants from combustion of fossil fuels for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of chronic respiratory disease and reduced respiratory function
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• Increased risk of falling accidents form maintenance of residential solar DHW and PV systems
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

AE-5: PREMIUM ENERGY PERFORMANCE LABELLING PROGRAM FOR EQUIPMENT AND APPLIANCES

DESCRIPTION OF MEASURE

General description:

This Measure involves a recognition label for the most energy efficient products within selected product categories, including such categories as:

- HVAC equipment (including HRVs)
- Major appliances
- Domestic water heaters
- Lighting
- Windows and doors
- Motors
- Gas fireplaces.

This Measure is intended to provide market recognition for the most energy efficient products in a category, and by so doing encourage both the manufacture and sale of such products. Typically, recognition would be restricted to the top 15-20% (notional) of products, but the actual level would vary by category. Premium energy performance labelling is not considered appropriate for all types of products. For instance, in categories with little differentiation in energy use between competing products, this Measure would not be applicable.

The design of the Measure would need to allow for future development of products, with respect to the thresholds for recognition. This Measure should build on, and be implemented in association with, the existing Energuide program.

Type of measure:	Market recognition
Time frame:	10 years starting in 2001
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Equipment manufacturers/distributors; retailers; building owners; home owners
Responsibility:	NRCan, provinces, manufacturers, utilities
Relationship to other measures:	This Measure will build on AE-1 (minimum efficiency standards) if adopted, by encouraging marketing and sale of products with energy performance that is significantly above minimum levels. It will be supported most directly by AE-6, which will provide tax incentives relating to the labelled products. It will also be supported by AE-4 and AE-8. More generally, this Measure will have significant interaction with most other Measures. These interactions need to be considered in the analysis of combinations of Measures.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **370 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for retrofit, renovation, and equipment replacement scenarios, and for new housing. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

Overall, this Measure provides positive environment and health impacts with no significant anticipated social impacts. Improved appliance and equipment efficiency results in fewer local emissions, with corresponding improvements to ambient air quality and related respiratory health benefits. Reduced electricity demand also contributes to reduced non-GHG emissions at the point of generation.

Economic impacts are not expected to be significant unless there is a resulting increase in appliance/equipment price that substantially exceeds the related energy cost savings. As a voluntary program, any increased spending by homeowners will come from available disposable income.

For further discussion, refer to the Other Impacts Assessment Sheet attached to ***Measure AE-8: Equipment Leasing Facilitation Program*** (a single Assessment Sheet has been prepared for both AE-8 and AE-5).

COSTS AND FUNDING

Estimated total cost	The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$430 million.** The administrative and related costs are estimated to be **$12 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$310 million** over the life of the actions stimulated by the measure.
Source of funds	This Measure would be supported on a cost shared basis by federal and provincial governments, and by industry through contributions in kind.

OTHER INFORMATION

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: AE-5 Premium Energy Performance Labelling Program for Equipment & Appliances

See OTHER IMPACTS ASSESSMENT SHEET: AE-8 Equipment Leasing Facilitation

AE-8: EQUIPMENT LEASING FACILITATION PROGRAM

DESCRIPTION OF MEASURE

General description:

This Measure would facilitate uptake of new technology through leasing arrangements, removing risk factors for owners. It depends on private sector initiative involving both the manufacturers of the equipment in question, and financial and leasing companies. To encourage development of an industry-wide initiative, leadership by industry associations will be essential.

Type of measure:	Financing
Time frame:	10 years starting in 2001
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Building owners; home owners; tenants
Responsibility:	Utilities or subsidiaries; manufacturers or other agents; financial and leasing companies; ESCOs
Relationship to other measures:	This Measure will support Measures R-4A, R-5A, R-3, R-6B, and AE-5.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **300 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This enabling Measure is designed to increase the impact of several other Measures. Accordingly, this Measure was analysed by applying multipliers to the impacts associated with these other Measures. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

Overall, this Measure provides positive environment and health impacts with no significant anticipated social impacts. This Measure also provides positive economic impacts. Programs such as this are expected to increase the penetration of more energy efficient equipment, such as those identified in Measure AE-5. This provides potential benefits to both industry, through increased sales activity, and to occupants. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$360 million.** The program administrative and related costs are estimated to be **$5 million.** These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$290 million** over the life of the actions stimulated by the Measure.
Source of funds	The administrative costs of the overall program would be supported on a cost shared basis by federal and provincial governments. This Measure would otherwise be self-financing, with private sector sources providing capital and delivery of the leasing services.

OTHER INFORMATION

Program requires a "champion" to succeed.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: AE-8 Equipment Leasing Facilitation Program and AE-5 Premium Energy Performance Labelling Program for Equipment & Appliances

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• To the extent that the measure reduces overall capital and operating costs, would be positive • Little impact expected
	Housing Industry Impacts	Impact on builder margins	• To the extent that costs are reduced, could be positive
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products
	Competitiveness	Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improve exports
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
		Related impacts on ozone depleting substances	• Potentially increased emissions of ozone depleting substances from increased use of heat pumps and early retirement of air conditioning and refrigeration equipment
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of boiler condensate
	Terrestrial Effects	Related effects on disposal of materials	• Increased disposal of toxic materials due to production and disposal of PV panels
		Other	• Decreased damage to crops and plants from reduced emission of air pollutants from combustion of fossil fuels on site for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of respiratory disease and reduced respiratory function

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• Increased risk of falling accidents from maintenance of residential solar DHW and PV systems
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

R-7V: ENERGUIDE FOR HOUSES PROGRAM - VOLUNTARY

DESCRIPTION OF MEASURE

General description:

This Measure is an extension and expansion of existing programs to promote purchase of energy efficient new and existing homes. Households that wish to participate would receive a home energy audit and, based on the results of the audit and any retrofit actions undertaken, these houses would be rated/labelled with respect to energy efficiency. Renewable energy measures in the home would also be reflected in the rating.

The ratings must attain credibility with customers and stakeholders, yet at the same time be technically sound and measurable. The program must be closely linked to energy efficiency services, so that homeowners can make investments with a low level of administrative overhead and as part of a streamlined process. A significant investment in the training and certification of auditors would be required.

This Measure anticipates a substantial expansion Energuide activity, rising to a level of about 40,000 houses per year.

Type of measure:	Information and market based (suasion)
Time frame:	10 years starting in 2001
Target subsector:	Existing low rise residential; new low rise residential and major additions
Target stakeholder group:	Builders, renovators, and developers; real estate industry; home owners and home buyers
Responsibility:	NRCan, provinces/municipalities, buildings industry, real estate industry
Relationship to other measures:	This Measure will influence Measures R-4A, R-5A, R-3, R-6B, and R-1B. For new housing, there is disagreement whether this Measure will support the R-2000 program (R-5A), or lead to market confusion. This Measure is also closely related to R-3 (see Other Information below).

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **220 kilotonnes** in the year 2010, relative to the business as usual scenario. Of this, an estimated 190 kilotonnes is associated with existing housing, and the remaining 30 kilotonnes with new housing. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This enabling Measure is designed to increase the impact of several other Measures. Accordingly, this measure was analysed by applying multipliers to the impacts associated with these other Measures. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

This Measure increases the penetration of EE housing (see Measures R1-A, R-3, R-6A and R-5A) and, therefore, provides similar positive environment and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions stimulated by this Measure contribute to smog reduction and provide related respiratory health benefits. Similarly, occupant exposure to external noise and vibration is reduced by improved envelope construction. Significant economic impacts are not anticipated.

For further discussion, refer to the Other Impacts Assessment Sheet attached to ***Measure R-7M Energuide for Houses – Mandatory*** (a single Assessment Sheet has been prepared for both variations of the Energuide for Houses Measure).

COSTS AND FUNDING

Estimated total cost

The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$350 million.** The administrative and related costs are estimated to be about **$50 million,** of which $40 million is for testing costs estimated at $150 per unit. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$200 million** over the life of the actions stimulated by the measure.

This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.

Source of funds

Testing costs could be paid by the federal government following the current Energuide for Houses model, or by other government agencies. The remaining costs of program implementation would be shared between government agencies and participating private sector organizations.

OTHER INFORMATION

A voluntary Energuide for Houses is also incorporated in Measure R-3, and a mandatory alternative is presented as Measure R-7M.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

CHBA supports this Measure but believes it should be limited to existing housing only.

OTHER IMPACTS ASSESSMENT SHEET: R-7V Energuide for Houses Program - Voluntary

See OTHER IMPACTS ASSESSMENT SHEET: R-7M Energuide for Houses Program - Mandatory

R-6B: R-2000 for Existing Dwellings Renovation Program

DESCRIPTION OF MEASURE

General description:

This market leadership program is similar in concept to the R-2000 program for new housing (Measure R-5A). Specifically, the program will encourage and support high level retrofit of a small portion of the existing housing stock across the country. In so doing, the program will generate greenhouse gas reductions and energy savings in the participating households, while also providing leadership in the marketplace.

This Measure will incorporate key features of the established R-2000 program. This will likely include:

- Development of an R-2000 retrofit guideline incorporating high levels of energy efficiency, advanced retrofit techniques, and good building practice
- Training and certification of R-2000 retrofit contractors
- Independent evaluation and certification of R-2000 retrofits (perhaps delivered via the EnerGuide for Houses audit and label)
- Strong marketing of the program and its benefits, and of the R-2000 brand name.

Initiation of work on this Measure can begin immediately, but 2 years have been allowed for the design and developmental stages. It is proposed that the Measure grow over the first 5 years to a level two thirds the size of the R-2000 program for new housing, and then remain at this level until 2010. Based on the penetration rate proposed in Measure R-5A, this implies an annual target of over 6500 certified R-2000 retrofits. As in the case of the existing R-2000 program, for modelling purposes this number has been increased by 50% to allow for clones and, more importantly, broader market impact.

This Measure would be coordinated with Measure R-3 (National Energy Efficient Housing Renovation and Retrofit Program). As such, participants would qualify for the tax reduction incentive incorporated into the design of R-3.

The actions included as part of this measure are listed in the attached Measure Data Sheet.

Type of measure:	Market leadership, information and suasion, supported by tax incentive.
Time frame:	9 years starting in 2002
Target subsector:	Existing low rise residential
Target stakeholder group:	Renovation contractors and homeowners; also supporting stakeholders such as lenders; equipment manufacturers/distributors; and engineering and architectural firms.
Responsibility:	Federal government (NRCan or CMHC), together with an industry committee providing leadership and direction (primarily renovators, but also others such as building and equipment suppliers). Other participants could include provinces, municipalities, financial institutions, and utilities. Key to successful implementation will be full involvement of industry as partners.
Relationship to other measures:	This program has links to several other measures, including R-3 (National Energy Efficient Housing Renovation and Retrofit Program), R-5A (Strengthened R-2000 Program), R-10 (Residential Retrofit Guidelines and Installation Standards), and R-7V (EnerGuide for Houses). The program is supported by several additional enabling measures (R-6A, AE-4, and AE-8).

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **200 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for renovation and equipment replacement scenarios. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

The economic, environmental, health and social impacts of this Measure are expected to be similar to the impacts of Measure R-3. For further discussion, refer to the Other Impacts Assessment Sheet attached to **Measure R-3 National Energy Efficient Housing Renovation and Retrofit Program**.

COSTS AND FUNDING

Estimated total cost	The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$350 million.** As noted, participants in this Measure would qualify for the tax reduction incentive associated with Measure R-3; the cost of this incentive is estimated to be **$85 million.**[6] The administrative and related costs are estimated to be **$90 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated to exceed **$180 million** over the life of the actions stimulated by the measure.
Source of funds	The cost of the incentive would be incurred by the governments providing relief from GST/PST/HST. Other costs of program implementation would be provided by the federal and provincial governments according to a cost sharing formula to be determined. Industry (including utilities) sponsorship would be sought.

OTHER INFORMATION

"R-2000 for Existing Dwellings" is used here only as a descriptive name for the Measure. A different name could be adopted when the program moves to implementation.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

As noted above, it is proposed that participants in this program would qualify for the tax reduction incentive incorporated into Measure R-3. CHBA does not support the incentive element of Measure R-3, and does not believe that there should be any incentive particular to R-6B (although the marketing strategy could involve free testing and/or registration costs).

[6] The incentive offsets the cost of the action from the point of view of the participant, but does not affect the actual cost of the action per se. In other words, the cost of the incentive cannot be added to the other costs when determining the total cost of the Measure. However, the cost of the incentive does affect the cost of the Measure to the organization responsible for implementation of the Measure.

OTHER IMPACTS ASSESSMENT SHEET: R-6B R-2000 for Existing Dwellings Renovation Program

See OTHER IMPACTS ASSESSMENT SHEET: R-3 National Energy Efficient Housing Renovation and Retrofit Program

R-5A: STRENGTHENED R-2000 PROGRAM

DESCRIPTION OF MEASURE

General description:

This Measure involves strengthening the R-2000 program. The target is to shift the market so that certified R-2000 homes achieve a penetration rate of 10% of new construction (compared to a business-as-usual penetration of 3% in 2010).

This Measure also recognizes that the R-2000 program has an important indirect (market pull) impact. Apart from R-2000 "look alikes", the program has influenced construction practices in the housing industry as a whole. The strengthened R-2000 Program can be expected to continue to influence the wider market. To allow for this market pull effect, the penetration rate for R-2000 has been increased an additional 5%. This figure is indicative only.

It is anticipated that the total market penetration will ramp up over the initial six years from the current low level to 15% (10% + 5%) by 2005, after which the rate will hold steady until 2010. To achieve this target market penetration will require significant additional mobilization on the part of government, the building industry and other stakeholders. It will also require more resources for marketing, access to preferred mortgage rates (in cooperation with the banking community), expanded builder training and certification, streamlined requirements and certification processes, and more. Without strong commitment from governments and industry, the target penetration will not be achieved.

This Measure assumes that the performance requirements in the R-2000 standard are ratchetted up each five years, and that renewable energy technologies are among the actions encouraged by the program (by means of credit for these technologies in a performance-based framework).

Type of measure:	Market leadership, information and suasion
Time frame:	Ongoing program; efforts to strengthen to be initiated immediately
Target subsector:	New low rise residential and major additions
Target stakeholder group:	Builders/developers and homeowners; also supporting stakeholders such as lenders; equipment manufacturers/distributors; and engineering and architectural firms.
Responsibility:	Federal government and industry partners, including CHBA. Other participants would include provinces, municipalities, financial institutions and utilities.
Relationship to other measures:	Measure R-4A (MNECH), and Measures AE-1 and AE-5 (efficiency of appliances and equipment) influence and affect the impact of R-2000. AE-6, if adopted, would provide sales tax reduction on energy efficient products used in R-2000 homes. In addition, this Measure will be influenced by enabling Measures R-6A, AE-4, AE-8, R-11, and R-7B. The relationship with R-7B (Energuide for Houses) would require particular examination.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **180 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet. Note that this GHG reduction is not the total attributable to the R-2000 program, but rather the amount that is above what is already anticipated in the business as usual scenario.

Summary of market penetration	This measure was modelled for new housing. Estimated market penetration rates are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

This Measure provides positive environment and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions associated with this Measure contribute to smog reduction and provide related respiratory health benefits. Similarly, occupant exposure to external noise and vibration is reduced by improved envelope construction.

Economic impacts are also positive. Industry is positively affected due to increased spending levels. In addition, the requirement for increased skill levels and greater demand for EE products also provide opportunities to boost overall industry competitiveness. Affordability is not a concern as this is a voluntary program in which owners are purchasing a combination of increased comfort and reduced operating cost. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$240 million.** The administrative and related costs are estimated to be **$70 million.** These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$160 million** over the life of the actions stimulated by the measure.
Source of funds	It is proposed that the **$70 million** cost of program implementation be shared between governments (2/3 of the cost) and industry (1/3 of the cost). The government portion would be shared between federal and provincial. The industry portion would include utility contributions.

OTHER INFORMATION

The Table does not believe that incentives should be provided to support the purchase of R-2000 homes. Additional resources should be applied to marketing, training, establishing financing arrangements, product development, and other activities that will over time increase penetration and transform the market.

Other innovative strategies will be required to help achieve the desired penetration rates, including targeting blocks of housing (including government housing).

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: R-5A Strengthened R-2000 Program

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• Minimal impact since this is a voluntary measure; higher capital costs of R-2000 would be affordable to those who choose to purchase them • Analysis of construction costs indicates increased costs for a typical new house of roughly $6,400 across Canada - a low of $3,400 in Atlantic Canada and a high of $9,000 in BC.
	Housing Industry Impacts	Impact on industry activity	• Increased total spending due to higher costs associated with R-2000 construction. Positive impact on builders and sub-contractors involved in R-2000 building
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products from higher levels in R-2000 homes; also related benefits in terms of increased employment
	Competitiveness	Implications on required industry skill levels	• Need for additional training and education for builders and trades
		Export opportunities	• Possible spin-offs from enhanced demand for EE building products and techniques • Could result in increased efficiencies in development and manufacture of EE products and improve exports
	Employment	Net jobs created or lost	
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
	Terrestrial Effects	Other	• Decreased damage to crops, forests, other plants and buildings from reduced emission of air pollutants from combustion of fossil fuels for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of respiratory disease and reduced respiratory function

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise from improvements to building envelope.
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• No anticipated impacts
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

R-1A: ASSISTED HOUSING PROGRAM

DESCRIPTION OF MEASURE

General description:

This is a Measure that will undertake energy efficiency improvements in the social housing/assisted housing stock. The cost of the energy efficiency improvements would be borne by the public sector agencies (federal and provincial) that own or support social housing. The budget for these activities would, it is proposed, be a special allocation that would not reduce the funds otherwise available for social housing.

This is considered an important Measure, both because of the opportunities and needs that exist in the social housing stock, and because this is an initiative that demonstrates government leadership to the private sector. Penetration rates for this Measure have been set at a significantly higher rate than for other retrofit Measures, in recognition of the opportunity for direct implementation by public sector agencies.

In addition to direct funding from provincial or federal sources, other financing sources would include loans from provincial or municipal revolving funds, leveraged involvement of private sector financial institutions, and/or other alternative financing approaches.

The financing component would be supported by advisory and educational activities. Implementation would involve community-based delivery agents, ESCOs, and other partners. The program would be supported by several of the other enabling measures (see below).

The actions included as part of this measure are listed in the Measure Data Sheet. Apart from the actions listed, this Measure could incorporate a weatherization initiative, based on the U.S. experience. This alternative has not been modelled at this time.

Type of measure:	Direct implementation of efficiency improvements by social housing agencies, supported by advisory and information services
Time frame:	11 years starting in 2000
Target subsector:	Existing low rise residential (social housing)
Target stakeholder group:	Building owners, renters
Responsibility:	Provinces; also municipalities, federal government, other financing sources
Relationship to other measures:	Supported by AE-5 and AE-6, and by several enabling measures (R-10 and R-7V). This Measure would also need to be closely coordinated with R-3 and R-1B.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of **about 180 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for retrofit, renovation, and equipment replacement scenarios. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

Overall, this Measure provides positive environment and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions associated with this Measure contribute to smog reduction and provide related respiratory health benefits. Building envelope improvements demand proper installation and operation of ventilation systems to ensure that indoor air quality is maintained.

Economic impacts are also positive. Industry is positively affected through increased renovation activity and increased demand for related EE products. Little effect is expected on tenant rents. However, there is need for new capital to finance the retrofits; otherwise, there could be a reduction in the availability of social housing units.

Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost The capital cost of actions stimulated by this measure (as modelled) is estimated to be **$350 million.** The administrative and related costs are estimated to be about **$5 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at approximately **$170 million** over the life of the actions stimulated by the measure.

Source of funds The funds for this Measure (both action costs and the administrative and related costs) would be provided on a cost shared basis by the federal and provincial agencies responsible for social housing.

OTHER INFORMATION

Much of he social housing stock is in mid and high rise residential. The impact of this Measure could be increased by extension to these other segments of the residential sector.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: R-1A Assisted Housing Program

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• Most occupants of social housing pay rent according a rent-geared-to-income (rgi) scale – measure would not impact on their rents. Little effect on market rent tenants (a minority) since measure not likely to affect market rents
	Impact on Social Housing providers	Impact on project costs (which need to be funded by governments)	• Analysis shows capital costs exceed savings. Capital costs would have to come from new sources due to severe restrictions on social housing spending in all jurisdictions. Lower energy costs would be realized by social housing providers or tenants.
	Housing Industry Impacts	Impact on builders	• Positive impact on contractors and sub-contractors involved in EE renovations and retrofits
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products from higher levels of EE renovations/retrofits, and related benefits in terms of increased employment
	Competitiveness	Increase/decrease in Canadian market share of building products	• Positive spin-offs from enhanced demand for EE building products and techniques
		Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Employment	Net jobs created or lost	• Related benefits in terms of increased jobs
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of boiler condensate
	Terrestrial Effects	Related effects on levels of material consumption	• Increased building material consumption from increased rate of envelope and equipment retrofits, leading to negative ambient air quality, aquatic and terrestrial impacts
		Related effects on disposal of materials	• Increased disposal of building materials leading to landfill impacts

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
		Other	• Decreased damage to crops, forests, other plants and buildings for reduced emission of air pollutants from combustion of fossil fuels
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of chronic respiratory disease and reduced respiratory function
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise from improvements to building envelope
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No substantial impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

R-1B: LOW INCOME HOUSING PROGRAM

DESCRIPTION OF MEASURE

General description:

This Measure is designed to provide financing and assistance for energy efficiency improvements in the low income owner-occupied stock (retrofit, weatherization, heating systems, etc.). Grants of up to $10,000 (notional) would piggyback on the RRAP program. Additional financing would involve loans from provincial or municipal revolving funds, leveraged involvement of private sector financial institutions, and/or other alternative financing approaches. For purposes of modelling, it has been assumed that the average incentive will be 20% of the cost of the actions stimulated by the Measure.

The financing component would be supported by advisory and educational activities, and could include a weatherization initiative based on the U.S. experience (this alternative has not been modelled at this time). Implementation would involve community-based delivery agents, and other partners. The program would be supported by several of the other enabling measures (see below), and by several elements of Measure R-3.

The actions included as part of this measure are listed in the Measure Data Sheet. The Measure has been focussed on incremental cost actions, to enhance cost effectiveness.

Type of measure:	Grant and loan financing, and community based retrofit
Time frame:	11 years starting in 2000
Target subsector:	Existing low rise residential
Target stakeholder group:	Home owners
Responsibility:	Federal government/CMHC, provinces, utilities; also municipalities and other financing sources
Relationship to other measures:	Supported by AE-5 and AE-6, and by several enabling measures (R-10 and R-7V). This Measure would also need to be closely coordinated with R-3 and R-1A.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **180 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for renovation and equipment replacement scenarios. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

Overall, this Measure provides positive environmental and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions stimulated by this Measure contribute to smog reduction and provide related respiratory health benefits.

Economic impacts are also positive. Industry is positively affected through increased renovation activity and increased demand for related EE products.

In the short term, no significant effects are expected on homeowners' ability to afford housing. Energy savings are assumed to be used to partially amortize the required EE capital expenditure, but significant grants will be required to fully offset net amortized costs.

Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING	
Estimated total cost	The capital cost actions stimulated by this measure (as modelled) is estimated to be approximately **$260 million.** The cost of the incentive anticipated by this program as currently described is estimated to be about **$50 million.**[7] The administrative and related costs are estimated to be about **$20 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$160 million** over the life of the actions stimulated by the measure.
Source of funds	This Measure would be supported on a cost shared basis by federal and provincial governments.
OTHER INFORMATION	
The largest group of low income home owners are seniors, typically in older housing.	
RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS	
This Measure has been included in Options Packages A and B.	

[7] The incentive offsets the cost of the action from the point of view of the participant, but does not affect the actual cost of the action per se. In other words, the cost of the incentive cannot be added to the other costs when determining the total cost of the Measure. However, the cost of the incentive does affect the cost of the Measure to the organization responsible for implementation of the Measure.

OTHER IMPACTS ASSESSMENT SHEET: R-1B Low Income Housing Program

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Housing price/rent	Capital cost impact of measure	• Planned grants of up to $10,000 would lead to reductions in the costs of EE retrofits for low-income owners
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• Providing grants are available, affordability of retrofits for low income owners would be enhanced - lower operating costs would improve affordability for owners. Analysis of costs and savings indicate that grants averaging up to $5,000 to $6,000 would be required to offset the difference between amortized costs and energy savings
	Housing Industry Impacts	Impact on builder margins	• Positive impact on overall levels of renovation/retrofit work since low-income owners would be unlikely to undertake significant work without incentives
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products to extent that measure would result in increased retrofit activity
	Competitiveness	Implications on required industry skill levels	• Need for additional training and education for builders and trades if increase in demand for renovations is significant
		Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Employment	Net jobs created or lost	
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW and in electrical generation facilities
	Aquatic Effects	Related impacts on water consumption	• Reduced groundwater and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of acidic condensate
	Terrestrial Effects	Related effects on levels of material consumption	• Increased building material consumption from increased rate of envelope and equipment retrofits, leading to negative ambient air quality, aquatic and terrestrial impacts
		Related effects on disposal of materials	• Increased disposal of building materials leading to landfill impacts

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
		Other	• Decreased damage to crops, forests, other plants and buildings for reduced emission of air pollutants from combustion of fossil fuels for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of chronic respiratory disease and reduced respiratory function
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise from improvements to building envelope
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• Owners may be able to remain longer in the dwelling due to increased comfort, lower energy bills, etc.

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

R-6A: HOUSING ENERGY TECHNOLOGY DEMONSTRATION PROGRAM

DESCRIPTION OF MEASURE

General description:

This is an enabling measure intended to generate long-term improvements in energy efficiency in housing. Elements would include:

- Demonstration of new design approaches and practices
- Demonstration of "market-ready" technology (advanced integrated mechanical systems, renewable technologies, home automation technology, etc.)
- Extension activities relating to the demonstrations (preparation of guidelines, dissemination of information, workshops, etc.)

Type of measure:	Demonstration
Time frame:	10 years starting in 2001
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Builders/developers, equipment manufacturers/distributors, engineers and architects, building owners, home owners
Responsibility:	NRCan, CHBA, and other industry partners
Relationship to other measures:	This Measure will support Measures R-4A, R-5A, AE-1, R-3, R-6B.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of **about 160 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet. Note that this estimate of impact is derived by assuming that the demonstration program will strengthen the impact of other Measures. As such, this estimate is subjective, and is presented primarily for illustrative purposes.
Summary of market penetration	This measure was analysed by applying multipliers to the impacts associated with selected other Measures. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

This Measure provides positive economic impacts. There is potential for enhanced industry profitability as builders adapt EE technologies to their products. The increased demand for EE products provides further economic stimulation to the product suppliers.

Given the enabling nature of this Measure, no specific environment, health or social impacts were identified. However, in general, continued improvements to technology and industry skill levels are expected to provide improved housing conditions. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost

The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$250 million.** The administrative and related costs are estimated to be about **$60 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant are estimated at about **$140 million** over the life of the actions stimulated (indirectly) by the measure. As with estimates of greenhouse gas reduction, these estimates are subjective, and are presented primarily for illustrative purposes.

This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.

Source of funds

Based on experience with demonstration programs of this nature, it is anticipated that the costs of program implementation will be incurred by governments (20%) and industry (80%). This includes direct and indirect costs of program delivery, but does not include the capital cost of the actions stimulated by this Measure. The government portion of the costs of program implementation would be cost shared between the federal government and the provinces.

OTHER INFORMATION

The challenges associated with demonstration programs are believed to be greatest in existing housing. Transferring the results of demonstrations to the owners of existing homes is more difficult than is the case with builders and developers of new homes.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: R-6A Housing Energy Technology Demonstration Program

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• No apparent impacts
	Housing Industry Impacts	Impact on builder profitability	• Potential for enhanced industry profitability as builders adapt EE technologies to their products -- either through more efficient procedures or marketing advantages related to EE
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products from higher levels of EE construction – related benefits in terms of increased employment
	Competitiveness	Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products, and improved exports
	Employment	Net jobs created or lost	
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• No specific impacts identified • In general, continued improvements to technology would be expected to provide improved housing and environmental conditions
		Related impacts on ozone depleting substances	
	Aquatic Effects	Related impacts on water consumption	
		Related impacts on amount and toxicity of waste water production/disposal	
	Terrestrial Effects	Related effects on levels of material consumption	
		Related effects on disposal of toxic materials	

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• No specific impacts identified • In general, continued improvements to technology would be expected to provide improved living conditions
	Exposure to Contaminants	Related effects on human exposure to other, non air-borne pollutants	
	Noise	Related effects on human exposure to excessive noise or vibrations	
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No significant impacts expected

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

AE-4: TECHNOLOGY COMMERCIALIZATION PROGRAM (includes renewable technologies)

DESCRIPTION OF MEASURE

General description:

This Measure would promote technologies such as integrated systems/heat pumps; solar & instantaneous domestic hot water heating systems; lighting (e.g., residential luminaires for residential and 347 volt dimmable ballasts); ground source heat pumps; and other proven technology that has not yet developed a significant market in Canada.

This Measure would support:

- Technology development aimed at reducing production costs
- Assessments of market potential
- Development of market infrastructure such as quality assurance, distribution channels, and service industries.

With respect to renewable energy technologies, a specific requirement may be improved definition and categorization of technologies and products, with the assistance of an organization such as the Canadian Standards Association.

This Measure also provides a vehicle by which expanded levels of support could be targeted at particular technologies (for instance, feasibility funding and incentives to assist in market development for renewable energy or other priority technologies). This expanded support option has not been included in the analysis of this Measure.

Type of measure:	Commercialization
Time frame:	10 years starting in 2001
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Equipment manufacturers/distributors; engineering firms; service industries
Responsibility:	Industry and NRCan
Relationship to other measures:	This Measure will support Measures R-4A, R-5A, R-3, R-6B and AE-1

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of **160 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet. Note that this estimate of impact is derived by assuming that the commercialization program will strengthen the impact of other Measures. As such, this estimate is subjective, and is presented primarily for illustrative purposes.
Summary of market penetration	This measure was analysed by applying multipliers to the impacts associated with selected other Measures. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

This Measure is expected to provide positive economic impacts. Programs such as this are expected to generate lower construction and/or operating costs. This provides potential benefits to both industry and occupants.

Given the enabling nature of this Measure, no specific environment, health or social impacts were identified. However, in general, the technical improvements and cost reductions resulting from this Measure are expected to provide improved housing conditions. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost

The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$250 million.** The administrative and related costs are estimated to be **$60 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$140 million** over the life of the actions stimulated (indirectly) by the measure. As with estimates of greenhouse gas reduction, these estimates are subjective, and are presented primarily for illustrative purposes.

This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.

Source of funds

Based on experience with commercialization programs of this nature, it is anticipated that the costs of program implementation will be incurred by governments (20%) and industry (80%). This includes direct and indirect costs of program delivery, but does not include the capital cost of the actions stimulated by this Measure. The government portion of the costs of program implementation would be cost shared between the federal government and the provinces.

OTHER INFORMATION

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: AE-4 Technology Commercialization Program

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Housing price/rent	Capital cost impact of measure	• If the Measure results in lower costs, impact could be positive • Technologies unlikely to be adopted by the industry unless savings exceed costs.
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• If the Measure results in lower construction or operating costs, could be beneficial
	Housing Industry Impacts	Impact on builder activity	• No discernable impact
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact expected
	Competitiveness	Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• No specific impacts identified • In general, continued improvements to technology would be expected to provide improved housing and environmental conditions
		Related impacts on ozone depleting substances	
	Aquatic Effects	Related impacts on water consumption	
		Related impacts on amount and toxicity of waste water production/disposal	
	Terrestrial Effects	Related effects on levels of material consumption	
		Related effects on disposal of toxic materials	
		Other	

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• No specific impacts identified • In general, continued improvements to technology would be expected to provide improved living conditions
	Noise	Related effects on human exposure to excessive noise or vibrations	
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

R-10: RESIDENTIAL RETROFIT GUIDELINES AND INSTALLATION STANDARDS

DESCRIPTION OF MEASURE

General description:

This is an enabling measure to improve the energy efficiency of renovations and equipment installations. The guidelines and installation standards would define best practices for retrofit, as a means to improve the quality and effectiveness of retrofit activity.

The guidelines and standards would support other Measures as listed below, and adherence to the guidelines/standards would be encouraged or required in these Measures. The guidelines/standards would also be available for use/adoption by, for instance, individual companies, industry associations, municipalities, and other agencies involved in retrofit.

Type of measure:	Information/guidelines
Time frame:	Guideline development to be initiated immediately; periodic update required
Target subsector:	Existing low rise residential
Target stakeholder group:	Builders and contractors, associations, engineering and architectural firms, other agencies involved in retrofit delivery
Responsibility:	Federal government, in conjunction with other stakeholders
Relationship to other measures:	This Measure will support Measures R-1A, R-1B, R-3, and R-6B

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of **about 130 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet. Note that this estimate of impact is derived by assuming that the guidelines and standards will strengthen the impact of other Measures. As such, this estimate is subjective, and is presented primarily for illustrative purposes.
Summary of market penetration	This measure was analysed by applying multipliers to the impacts associated with Measure R-3. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

This Measure may lead to a need for improved training and education for the housing industry. As this is an enabling Measure, other impacts are the indirect result of increased penetration rates and more effective implementation of the other affected Measures (e.g. Measure R-3). Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	This Measure does not directly stimulate investment in greenhouse gas reduction. Indirectly, however, this Measure will increase the effectiveness of other Measures. The capital cost of actions stimulated indirectly by this measure (as modelled) is estimated to be approximately **$210 million.** The administrative and related costs are estimated to be **$1 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at **$110 million** over the life of the actions stimulated (indirectly) by the measure. As with estimates of greenhouse gas reduction, these estimates are subjective, and are presented primarily for illustrative purposes.
Source of funds	Funding for this initiative would be provided by the federal government.

OTHER INFORMATION

This Measure is also incorporated into Measure R-3.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Packages A and B.

OTHER IMPACTS ASSESSMENT SHEET: R-10 Residential Retrofit Guidelines and Installation Standards

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• No apparent impacts • Guidelines may encourage retrofit actions which will entail costs and savings, but guidelines alone have no direct cost impact
	Housing Industry Impacts	Implications on required industry skill levels	• Need for additional training and education for builders and trades
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• No specific impacts identified • In general, continued improvements in building practice would be expected to provide improved housing and environmental conditions
		Related impacts on ozone depleting substances	
	Aquatic Effects	Related impacts on water consumption	
		Related impacts on amount and toxicity of waste water production/disposal	
	Terrestrial Effects	Related effects on levels of material consumption	
		Related effects on disposal of materials	
		Other	
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• No specific impacts identified • In general, continued improvements in building practice would be expected to provide improved living conditions
	Exposure to Contaminants	Related effects on human exposure to other, non air-borne pollutants	
	Noise	Related effects on human exposure to excessive noise or vibrations	

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No specific impacts expected

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

ADDITIONAL MEASURES INCLUDED IN OPTIONS PACKAGE B

R-4A: ADOPTION OF MORE STRINGENT MNECH BY PROVINCES

DESCRIPTION OF MEASURE

General description:

This measure sets in place provincial minimum energy efficiency regulations for new housing construction and major additions, based on a revised and more stringent Model National Building Code for Houses (MNECH). In five provinces, this would involve replacement/harmonization of existing codes with the MNECH; in the other provinces, it would involve adoption of an energy code for the first time.

This Measure has assumed that the MNECH is modified in two stages:

- First Stage - 2003 to 2006 - Improvement in thermal performance equal to half that achieved in the second stage MNECH (see below).
- Second Stage - 2007 to 2010 -Upgraded MNECH using an environmental multiplier of 1.5. This results in an improvement in thermal performance of ~22%over current MNECH.

Suggested implementation needs would include "basic maintenance" of the MNECH, and training for building officials and private inspectors.

Lack of enforcement of code requirements, increased activity in the underground economy, inadequate training, and various other factors will reduce the impact of this Measure below what would be theoretically expected following adoption of the code (i.e. below 100% penetration in new construction). Accordingly, reduced penetration rates have been assumed in modelling the impact of this Measure (85% -90% of new construction following adoption of the code, which is equivalent to 64% of new construction over the full period to 2010).

Type of measure:	Regulatory
Time frame:	Full adoption by provinces according to the schedule outlined above. Impact of Measure would be increased by prior voluntary commitment in the case of (1) public sector agencies that own or manage housing, or support housing development, and (2) private sector market leaders.
Target subsector:	New low rise residential and major additions (multi-unit buildings over three stories are covered by the MNECB)
Target stakeholder group:	Developers/builders, contractors, architects
Responsibility:	Provinces (and federal government); also municipalities (in those provinces where the MNECH can be adopted at the municipal level)
Relationship to other measures:	This Measure will be influenced by enabling Measures R-6A, AE-4, AE-8, R-11, and R-7V.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **615 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for new housing. Estimated market penetration rates are listed in the Measure Data Sheet.

SUMMARY OF OTHER IMPACTS

Analysis of construction costs and potential savings for typical new house indicates that the net cost of this Measure is in the range of $1500 (average across Canada). Ultimately, this would flow through to higher new and existing house prices. Energy savings are less than amortized construction costs, reducing affordability (based on initial data, Lampert and Pomeroy estimated that 4600 - 9200 fewer potential first time buyers could afford to purchase a starter home).

This Measure provides positive environment and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions stimulated by this Measure contribute to smog reduction and provide related respiratory health benefits. Similarly, occupant exposure to external noise and vibration is reduced by improved envelope construction.

Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost The capital cost actions stimulated by this measure (as modelled) is estimated to be approximately **$660 million.** The administrative and related costs are estimated to be **$6 million**. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$480 million** over the life of the actions stimulated by the measure.

Source of funds Costs for this Measure would be incurred at the federal level for development, maintenance, and promotion of the code, and at the provincial level for administration of the code. Additional costs would also be incurred at the municipal level for administration and enforcement in those provinces that do not currently regulate energy efficiency in new low rise construction. For the other provinces, these municipal costs are assumed to be part of ongoing municipal building code-related activity, and as such are not costed separately.

OTHER INFORMATION

NRC is reluctant to update the MNECH without provincial adoption of the current code. The five provinces that currently regulate energy efficiency in new low rise construction are B.C., Alberta, Manitoba, Ontario, and Quebec. These provinces typically represent about 9 of every 10 new homes built in Canada. Manitoba is the only province that has taken action to adopt the current version of MNECH in whole or part.

MNECH applies to major additions (over 10m^2 floor area and heated).

Capital cost estimates are based on HRV systems that rely on existing ducting where available, and include on OTC controller.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Package B.

CHBA and Fall River Village Ltd. are strongly opposed to this Measure. In addition, CHBA believes the GHG impact is overestimated, and the cost underestimated.

The Building Professionals Consortium does not agree with the Lampert and Pomeroy analysis of the affordability impact of this Measure (as summarized above and in the Other Impacts Assessment Sheet). BPC specifically disagrees with the assumption that increased new housing prices will strongly affect affordability in existing housing. Ken Klassen believes it unlikely that the R-4A will have a measurable impact on affordability.

OTHER IMPACTS ASSESSMENT SHEET: R-4A Adoption of More Stringent MNECH by Provinces

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Housing price/rent	Capital cost impact of measure	• Analysis of construction costs and potential savings for typical new house indicates that the net cost of this measure is in the range of $1500 (average across Canada) • Ultimately, increased costs would flow through to higher new and existing house prices
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• Negative impact on affordability • Energy savings are less than the amortized construction costs • Initial estimates indicated that between 4,600 and 9,200 fewer potential first-time buyers would be able to afford to purchase a starter home if this measure is implemented; revised estimates based on new Measure cost data are not available, but impacts are expected to be in the same range. • Also, would impact on costs and ultimately affordability in rental market
	Housing Industry Impacts	Impact on builder margins	• Increase in capital costs for new housing may not be fully reflected in higher prices due to competition from existing stock – would then squeeze builders' margins
		Impact on consumer preference for new vs existing or renovation	• Higher prices for new housing would shift demand towards existing stock and lead to some increase in existing house prices • Fewer first-time buyers would mean a reduction in overall demand for new ownership housing
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products to extent that measure would result in increased energy efficiency in construction; related benefits in terms of increased employment • Requiring MNECH for all new houses would reduce marketing advantage for builders from higher EE houses
	Competitiveness	Implications on required industry skill levels	• Need for additional training and education for builder and trades leads to more skilled work force
		Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Other		• Additional inspectors may be needed for code enforcement; training may be needed for current and new inspectors
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
		Related impacts on ozone depleting substances	• Potentially increased emissions of ozone depleting substances from increased use of heat pumps and early retirement of air conditioning and refrigeration equipment
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of boiler condensate
	Terrestrial Effects	Other	• Decreased damage to crops and plants from reduced emission of air pollutants from combustion of fossil fuels on site for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of chronic respiratory disease and reduced respiratory function
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise from improvements to building envelope
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• Increased risk of falling accidents from maintenance of residential solar DHW and PV systems
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

R-7M: ENERGUIDE FOR HOUSES PROGRAM - MANDATORY

DESCRIPTION OF MEASURE

General description:

This Measure is an extension and expansion of existing programs to promote purchase of energy efficient new and existing homes. Participating houses would receive a home energy audit and, based on the results of the audit and any retrofit actions undertaken, these houses would be rated/labelled with respect to energy efficiency. Renewable energy technologies in the home would also be reflected in the rating.

Two versions of the Measure have been modelled: mandatory (this Measure) and voluntary (R-7V). In the mandatory alternative, home owners and builders would be required to obtain the Energuide label prior to the sale of any home.

The ratings must attain credibility with customers and stakeholders, yet at the same time be technically sound and measurable. The program must be closely linked to energy efficiency services, so that homeowners can make investments with a low level of administration overhead and as part of a streamlined process. A significant investment in the training and certification of auditors would be required. In the mandatory alternative, enforcement considerations would need to be addressed.

Type of measure:	Regulatory
Time frame:	8 years starting in 2003
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Builders and developers; real estate industry; home owners and home buyers
Responsibility:	NRCan, provinces/municipalities, buildings industry, real estate industry
Relationship to other measures:	This Measure will influence Measures R-4A, R-5A, R-3, R-6B, and R-1B. For new housing, there is disagreement whether this Measure will support the R-2000 program (R-5A), or lead to market confusion.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **560 kilotonnes** in the year 2010, relative to the business as usual scenario. Of this, an estimated 470 kilotonnes is associated with existing housing, and the remaining 90 kilotonnes with new housing. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This enabling Measure is designed to increase the impact of several other Measures. Accordingly, this measure was analysed by applying multipliers to the impacts associated with these other Measures. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

This Measure increases the penetration of EE housing (see Measures R1-A, R-3, R-6B, and R-5A) and, therefore, provides similar positive environment and health impacts with no significant anticipated social impacts. Improvements to ambient air quality are significant as the actions stimulated by this Measure contribute to smog reduction and provide related respiratory health benefits. Similarly, occupant exposure to external noise and vibration is reduced by improved envelope construction. Significant economic impacts are not anticipated. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost

The capital cost of actions stimulated by this measure (as modelled) is estimated to be approximately **$800 million.** The administrative and related costs are estimated to be about **$280 million,** of which $265 million is testing costs estimated at $150 per unit. These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$460 million** over the life of the actions stimulated by the measure.

This Measure is designed to increase the impact of several other Measures. Incentive costs associated with these other Measures may be increased as a result.

Source of funds

Testing costs would be paid by home seller, buyer or builder. The remaining costs of program implementation would be paid by government agencies (federal, provincial, and municipal contribution to be determined).

OTHER INFORMATION

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Package B.

CHBA, Fall River Village Ltd., and Yukon Housing Corporation do not support this Measure.

OTHER IMPACTS - MEASURE R-7M: Energuide for Houses Program - Mandatory and R-7V Energuide for Houses Program - Voluntary

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
Economic	Housing price/rent	Capital cost impact of measure	• Additional costs associated with obtaining Energuide level – likely reflected in some increase in prices
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• According to analysis, capital costs of actions exceed discounted energy savings. Implementation of actions is voluntary, so unlikely many owners would participate unless market benefit expected. Implementation of actions could result in negative effects for homeowners if they are unable to pass on costs to potential buyers.
	Housing Industry Impacts	Impact on builder margins	• Increase in costs for new housing may not be fully reflected in higher prices (even in EE housing) due to competition from existing stock – would then squeeze builders' margins. Unlikely to be negative impact if implementation is voluntary
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products to extent that measure would result in increased investment in energy efficiency; related benefits in terms of increased employment
		Implications on required industry skill levels	• Need for training and certification of auditors. Also, additional training and education for builder and trades
		Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Employment	Net jobs created or lost	• Positive input expected, but not large
	Other	Impact on regulatory authorities	• Additional inspectors may be needed for monitoring of Energuide ratings
Environment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
		Related impacts on ozone depleting substances	• Potentially increased emissions of ozone depleting substances from increased use of heat pumps and early retirement of air conditioning and refrigeration equipment
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of condensate

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
	Terrestrial Effects	Related effects on levels of material consumption	• Increased building material consumption from increased rate of envelope and equipment retrofits, leading to negative ambient air quality, aquatic and terrestrial impacts
		Related effects on disposal of toxic materials	• Increased disposal of building materials leading to landfill impacts • Increased disposal of toxic materials due to production and disposal of PV panels
		Other	• Decreased damage to crops and plants from reduced emission of air pollutants from combustion of fossil fuels on site for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise from improvements to building envelope
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• No anticipated impacts
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

AE-6: REDUCED SALES TAX TO ENCOURAGE PURCHASE OF EE PRODUCTS IN NEW CONSTRUCTION

DESCRIPTION OF MEASURE

General description:

This Measure would remove the GST/PST/HST from energy-saving equipment and products used in new construction.[8] (Similar tax reductions are proposed for existing housing through Measure R-3.)

A primary focus for this Measure would be appliances and equipment addressed by Measure AE-5 (Premium Energy Performance Labelling Program for Equipment and Appliances). For these products, the tax reduction would be available only for units that have earned the premium energy performance label. The tax reduction should also be structured to encourage consumers to retire the older inefficient equipment that is being replaced (perhaps through an additional rebate).

Selected additional products with positive GHG impact would also be eligible for the tax reduction. This would include building materials such as insulation, and selected renewable energy technologies. For such purchases, specified eligible products (which may vary from province-to -province) would qualify for the tax reduction.

Detailed design of this Measure will be an critical step. In concept, the Measure is perceived to be a targeted program that minimizes "free-riders". As such, the tax reduction would be available only to the builders or buyers of new houses that meet a prescribed energy performance threshold. Measure R-7V (EnerGuide for Houses) provides a mechanism for determining eligibility for the tax reduction (presumably provided in the form of a rebate).

The actions included as part of this measure are listed in the Measure Data Sheet.

Type of measure:	Tax incentive
Time frame:	10 years starting in 2001
Target subsector:	New low rise residential and major additions; existing low rise residential
Target stakeholder group:	Equipment manufacturers/distributors; builders and developers; architects and contractors; building owners; home owners
Responsibility:	Federal and provincial governments
Relationship to other measures:	Closely related to Measure AE-1. Also supports R-3, R-1A, and R-1B.

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of **about 130 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This measure was modelled for retrofit, renovation, and equipment replacement scenarios, and for new housing. Estimated market penetration rates for each of the actions that make up this measure are listed in the Measure Data Sheet.

[8] For jurisdictions with no provincial or territorial sales taxes, alternative mechanisms would be required. As an alternative to sales tax reductions, accelerated depreciation could be considered for rental housing.

SUMMARY OF OTHER IMPACTS

Overall, by promoting increased use of EE products, this Measure provides positive environmental and health impacts with no significant anticipated social impacts. Improved appliance and equipment efficiency results in fewer local emissions with corresponding improvements to ambient air quality and related respiratory health benefits. Reduced electricity demand also contributes to reduced non-GHG emissions at the point of generation.

Reduced costs for EE products would be reflected in lower housing costs and/or lower operating costs, which improve affordability. The impact of this Measure would be reduced in those regions with no, or low, sales taxes (i.e., Alberta, territories) unless other alternatives are available. Fiscal impacts remain to be determined. Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	The capital cost actions included in this measure (as modelled) is estimated to be approximately **$200 million.** The administrative and related costs are estimated to be **$5 million**. The cost of the incentive anticipated by this program as currently described is estimated to be about **$90 million.**[9] These costs are cumulative to the year 2010. The value of the energy savings to the participant is estimated at about **$130 million** over the life of the actions stimulated by the measure.
Source of funds	The cost of the incentive and administrative costs would be incurred by the governments providing relief from GST/PST/HST.

OTHER INFORMATION

Modelling of this Measure is based on assumptions and cost estimates that are less certain than with other Measures.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been included in Options Package B.

[9] The incentive offsets the cost of the action from the point of view of the participant, but does not affect the actual cost of the action per se. In other words, the cost of the incentive cannot be added to the other costs when determining the total cost of the Measure. However, the cost of the incentive does affect the cost of the Measure to the organization responsible for implementation of the Measure.

OTHER IMPACTS ASSESSMENT SHEET: AE-6 Reduced Sales Tax to Encourage Purchase of Energy Efficient Product in New Construction

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Housing price/rent	Capital cost impact of measure	• Reduction in costs for EE products would be reflected in lower capital costs and lower prices
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• Favourable impact on affordability through both lower prices and reduced operating costs due to EE improvements • Modelling suggests that the removal of sales taxes would not be sufficient to offset the higher costs of some products
	Housing Industry Impacts	Impact on builder margins	• Positive impact due to reduction in capital costs for new housing, which may not be fully reflected in lower prices
		Impact on consumer preference for new vs existing or renovation	• Increased demand for new housing since lower prices for new housing would shift demand from existing stock
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products to extent that measure would result in increased sales (primarily a substitution effect)
	Competitiveness	Implications on required industry skill levels	• Need for additional training and education for builders and trades
		Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Employment	Net jobs created or lost	• Positive impact
	Distribution Effects	Disproportionate effects in a particular region of Canada or among particular social groups	• Impact could be less in provinces (i.e., Alberta) and territories with no (or low) sales taxes
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced of electrical generation
		Related impacts on ozone depleting substances	• Potentially increased emissions of ozone depleting substances from increased use of heat pumps and early retirement of air conditioning and refrigeration equipment
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of condensate

Impact Category	IMPACT		
	Identification	Characterization	Assessment & Comment
	Terrestrial Effects	Related effects on disposal of materials	• Increased disposal of toxic materials due to production and disposal of certain products (e.g. PV panels)
		Other	• Decreased damage to crops, forests, other plants and buildings from reduced emission of air pollutants from combustion of fossil fuels for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances • Reduced exposure to ambient air contaminants such as ground level ozone, NO_x, SO_2, particulates etc., leading to decreased incidence of chronic respiratory disease, and reduced respiratory function
	Noise	Related effects on human exposure ro excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• Increased risk of falling accidents from maintenance of residential solar DHW and PV systems.
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No anticipated impacts

Economic & Social Inputs by Lampert/Pomeroy

Environment & Health Inputs by Marbek / Sheltair / SAR

OTHER MEASURES THAT MERIT CONSIDERATION

R-11: BUILDING PERMIT FEEBATES

DESCRIPTION OF MEASURE

General description:

This Measure proposes to base building permit fees on the level of energy efficiency of a new building, as determined at the plans review stage. This Measure is conceived to be revenue-neutral for the municipality: building permit rebates for more efficient housing would be offset by increased fees for less efficient housing. This "feebate" is, in effect, a form of emissions credit.

Eligibility for building permit rebates could be restricted to R-2000 houses, or a progressive scale could be adopted with R-2000 required for the maximum rebate. The impact is highly sensitive to the number of municipalities that participate.

The Municipalities Table has expressed interest in this Measure, but has not at this time explored it in depth. The Buildings Table has referred this Measure to the Municipalities Table.

Type of measure:	Incentive
Time frame:	8 years starting in 2003
Target subsector:	New low rise residential and major additions
Target stakeholder group:	Developers/builders, building owners, home owners
Responsibility:	Municipal governments
Relationship to other measures:	This Measure would support R-5A (R-2000) and R-4A (MNECH, particularly prior to adoption of the Code by provinces).

SUMMARY OF GREENHOUSE GAS IMPACT

Expected greenhouse gas impact	This measure, as modelled, is expected to yield a greenhouse gas emission reduction of about **60 kilotonnes** in the year 2010, relative to the business as usual scenario. Additional detail is provided in the Measure Data Sheet.
Summary of market penetration	This enabling Measure is designed to increase the impact of several other Measures. Accordingly, this measure was analysed by applying multipliers to the impacts associated with these other Measures. The Measure Data Sheet identifies the specific multipliers that were used.

SUMMARY OF OTHER IMPACTS

This Measure increases the penetration of EE housing and, therefore, provides similar positive environment and health impacts with no significant anticipated social impacts.

Economic impacts are dependant on the net impact of permit increases as well as the resulting level of incremental investment in EE features and their associated pay back. The requirement for increased skill levels and greater demand for EE products also provide opportunities to boost overall industry competitiveness. Builders of non -EE homes would experience some negative impacts in the short term until their skill levels were upgraded. Overall, the economic effect is unlikely to be significant, except in areas having higher permit fees.

Further details are provided in the Other Impacts Assessment Sheet.

COSTS AND FUNDING

Estimated total cost	The capital cost actions stimulated by this measure (as modelled) is estimated to be approximately **$70 million.** The administrative and related costs have not been estimated. The value of the energy savings to the participant is estimated at about **$50 million** over the life of the actions stimulated by the measure.
Source of funds	This Measure is conceived to be revenue-neutral, with rebates covered by higher fees charged for less efficient houses. Administrative costs would be incurred by the municipality.

OTHER INFORMATION

Concerns raised regarding this initiative included the limited impact likely to be achieved without widespread municipal involvement. In many municipalities, building permit fees are low, limiting incentive. Unless linked to a program such as R-2000 or Energuide for Houses, costs and delays may be a concern.

RECOMMENDATIONS AND CONVERGENCE/DIVERGENCE OF STAKEHOLDER VIEWS

This Measure has been referred to the Municipalities Table. It is not included in any Options Package.

OTHER IMPACTS ASSESSMENT SHEET: R-11 Building Permit Feebates

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
Economic	Housing price/rent	Capital cost impact of measure	• Higher permit fees for non-EE dwellings would result in increase in costs/prices for these homes. Effect likely marginal outside of areas with high building permit fees (e.g., GTA and Lower Mainland, where fees are $1,000 to $2,000+). Fees in most centres range between $200 and $1,000 per typical house.
	Affordability for consumer/ occupants	Net impact of amortized capital cost vs net change in utility costs	• In major centres with high permit fees, could be negative for purchasers of modest starter homes; effect likely marginal outside of areas with high building permit fees
	Housing Industry Impacts	Impact on builder margins	• Some negative impact for builders of non-EE homes. Some positive impact for builders of EE homes
		Change in demand for related products & equipment and effects on Canadian suppliers	• Positive impact on demand for EE products to extent that measure would result in increased EE • Size of positive impact likely offset by negative impact on EE product industries.
	Competitiveness	Export opportunities	• Could result in increased efficiencies in development and manufacture of EE products and improved exports
	Other	Workload for regulatory authority	• Additional workload for building approval officials in determining EE of new dwellings
Environ-ment	Atmospheric Effects	Related impacts on other pollutants affecting ambient exterior air quality (e.g., SO_2, NO_x, VOC etc.)	• Improved local ambient air quality due to reduced emissions of SO_2, NO_x, and particulates released from combustion of fossil fuels on site for space heating and DHW • Improved ambient air quality due to reduced electrical generation
	Aquatic Effects	Related impacts on water consumption	• Reduced ground water and watershed impacts from reduced domestic water consumption
		Related impacts on amount and toxicity of waste water production/disposal	• Reduced impacts on aquatic environments due to reduced discharge of wastewater flows • Increased impacts on aquatic environments from discharge of condensate
	Terrestrial Effects	Other	• Decreased damage to crops and plants from reduced emission of air pollutants from combustion of fossil fuels on site for space heating and DHW and in electrical generation facilities
Health	Indoor air quality	Related effects on human exposure to indoor air pollutants	• Reduced exposure to indoor air contaminants (VOC's, particulates, etc.) due to improved ventilation in buildings – leading to decreased eye irritation, headaches, fatigue, respiratory diseases and cancer • Reduced exposure to combustion gases from the increased use of sealed combustion appliances

Impact Category	IMPACT		
	Identification	**Characterization**	**Assessment & Comment**
	Noise	Related effects on human exposure to excessive noise or vibrations	• Increased noise from replacement of furnaces with integrated space heat/DHW boilers • Decreased outside noise from improvements to building envelope
	Accidents	Related effects on human exposure to potential household accidents associated with the use and maintenance of the EE equipment etc.	• Increased risk of falling accidents from maintenance of residential solar DHW and PV systems
Social	Traditions, lifestyles and interpersonal relationships	Related effects leading to changes in personal, family or community routines or aesthetic enjoyment of surrounding living area.	• No identified impacts

Economic & Social Inputs by Lampert/Pomeroy

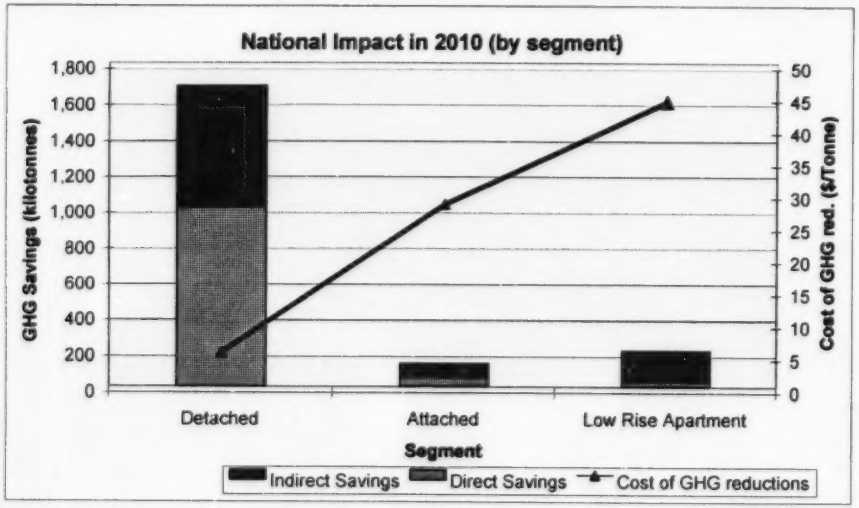
Environment & Health Inputs by Marbek / Sheltair / SAR

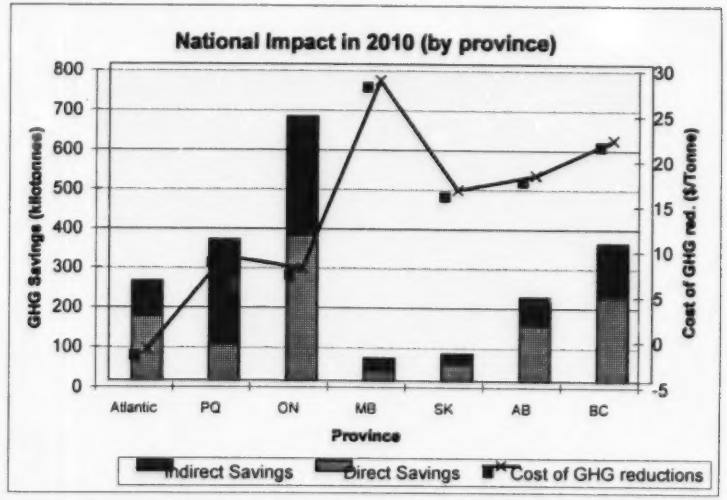
Measure Data Sheet: AE1 - National Standards for Equipment and Appliances

Summary of Market Penetration			
Actions	**Affected Stock:**	**Range of Market Penetration**	
		Existing	**New**
E2a, N11, N14 Windows/OTC ventilation controller	all dwelliings	32%	63%
E3a, E4a, N3, N4 High Effic. Furnaces and Boilers	all gas or oil heated dwellings	14%	27%
E5a, E6a, N5, N6 Integrated Space Heat & DHW	all gas or oil heated dwellings	14%	27%
E13, N12 Improved Appliances, lighting and motors	all dwelliings	32%	63%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$2,060.9
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$1,639.3
Total GHG reductions in 2010	1,999 kt/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	11 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$14.6
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$14.6





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	996	676	5
Attached	54	74	28
Low Rise Apartment	34	165	44
Total	1,084	915	

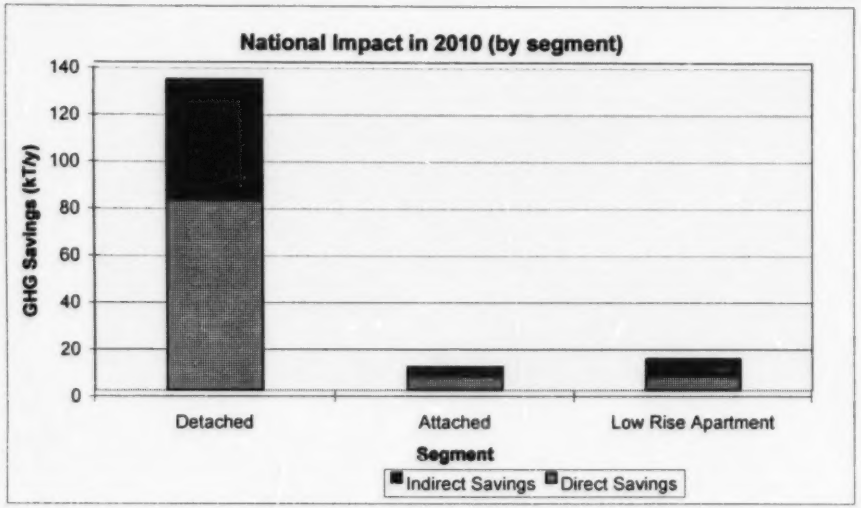
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	164	87	-1
Quebec	91	266	9
Ontario	369	299	7
Manitoba	27	31	28
Saskatchewan	45	26	16
Alberta	143	69	18
British Columbia	214	134	22
Total	1,084	915	

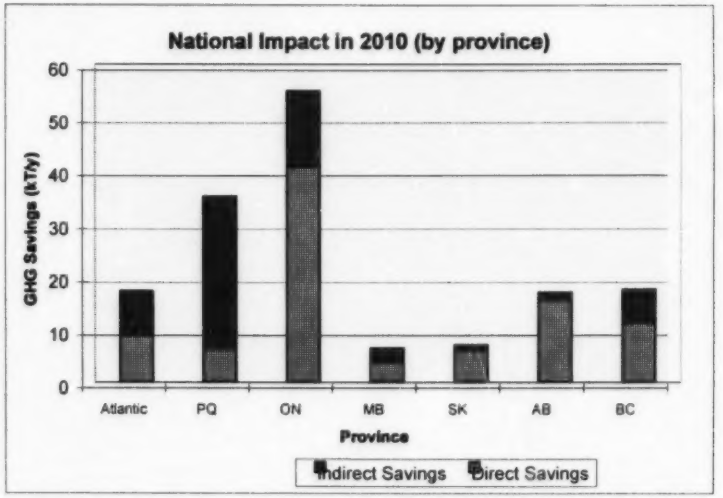
Measure Data Sheet: AE4 - Technology Commercialization Program

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
R3 National Energy Efficient Housing Renovation and Retrofit Program	4%
R4A Adoption of More Stringent MNECH by Provinces	5%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$246.0
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$140.8
Total GHG reductions in 2010	157 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	34 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$61.4
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$61.4





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Detached	81	51
Attached	6	4
Low Rise Apartment	6	7
Total	93	63

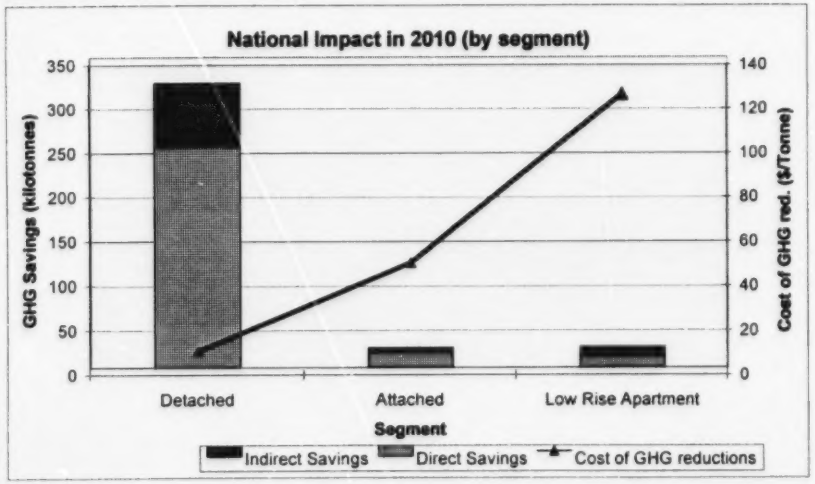
Region	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Atlantic	9	8
Quebec	6	29
Ontario	41	14
Manitoba	4	3
Saskatchewan	6	1
Alberta	15	2
British Columbia	11	6
Total	93	63

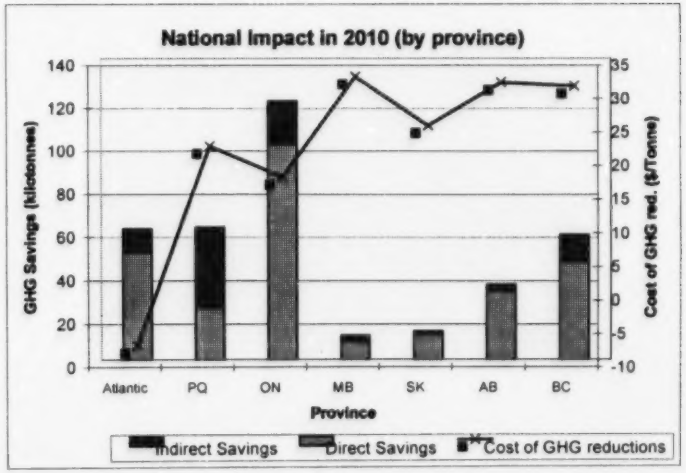
Measure Data Sheet: AE5 - Premium Energy Performance Labelling Program for Equipment and Appliances

Summary of Market Penetration			
Actions	**Affected Stock:**	**Range of Market Penetration**	
		Existing	**New**
E2a, N11, N14 Windows/OTC ventilation controller	all dwellings	5%	10%
E3a, E4a, N3, N4 High Effic. Furnaces and Boilers	all gas or oil heated dwellings	3%	5%
E5a, E6a, N5, N6 Integrated Space Heat & DHW	all gas or oil heated dwellings	3%	5%
E7a Air Source Heat Pumps	electrically heated with distribution systems	1%	2%
E8a Ground Source Heat Pumps	electrically heated with distribution systems	<1%	<1%
E9a Air Source Heat Pumps & DHW	electrically heated with distribution systems	1%	2%
E10a Ground Source Heat Pumps & DHW	electrically heated with distribution systems	<1%	<1%
E13, N12 Improved Appliances, lighting and motors	all dwellings	5%	10%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$433.4
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$306.5
Total GHG reductions in 2010	367 kt/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	17 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$11.8
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$11.8





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	249	72	7
Attached	17	5	47
Low Rise Apartment	13	10	123
Total	279	88	

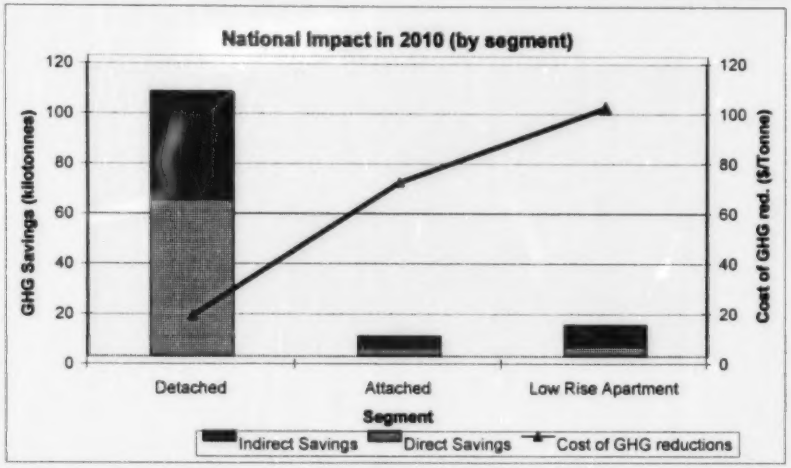
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	50	10	-8
Quebec	24	37	22
Ontario	100	20	17
Manitoba	8	3	32
Saskatchewan	12	1	25
Alberta	32	3	31
British Columbia	45	13	31
Total	279	88	

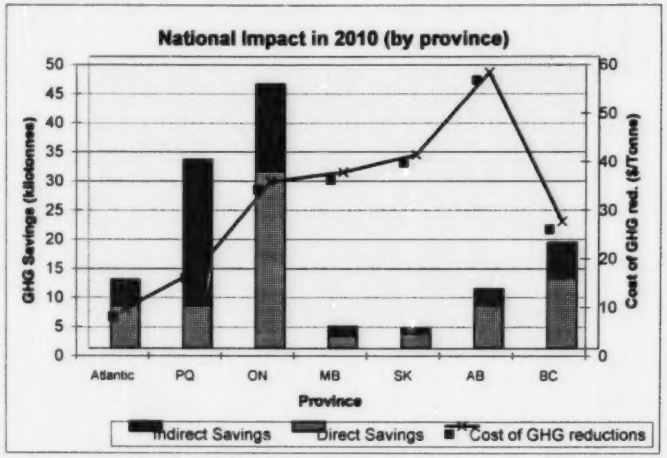
Measure Data Sheet: AE-6 - Reduced Sales Taxes to Encourage Purchase of EE Products in New Houses

Summary of Market Penetration			
Actions	**Affected Stock:**	**Range of Market Penetration**	
		Existing	**New**
N11, N12a, N16, Windows, HRV, Insulation	all new dwellings		9%
N3, N4 High Effic. Furnaces and Boilers	all new gas or oil heated dwellings		6%
N5, N6 Integrated Space Heat & DHW	all new gas or oil heated dwellings		6%
N7 Air Source Heat Pumps	new electrically heated with distribution systems		2%
N8 Ground Source Heat Pumps	new electrically heated with distribution systems		<1%
N9 Air Source Heat Pumps & DHW	new electrically heated with distribution systems		2%
N10 Ground Source Heat Pumps & DHW	new electrically heated with distribution systems		<1%
N12 Improved Appliances, lighting and motors	all new dwellings		11%
N13 Solar Water Heaters	all new dwellings		3%
N15 Photovoltaic Panels	all new dwellings		<1%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$195.7
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$125.7
Total GHG reductions in 2010	126 kt/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	28 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$5.2
Cost of incentive, if applicable (net present value)	$88.5
Total cost of program implementation (net present value)	$93.7





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	62	43	16
Attached	3	5	69
Low Rise Apartment	4	8	99
Total	70	56	

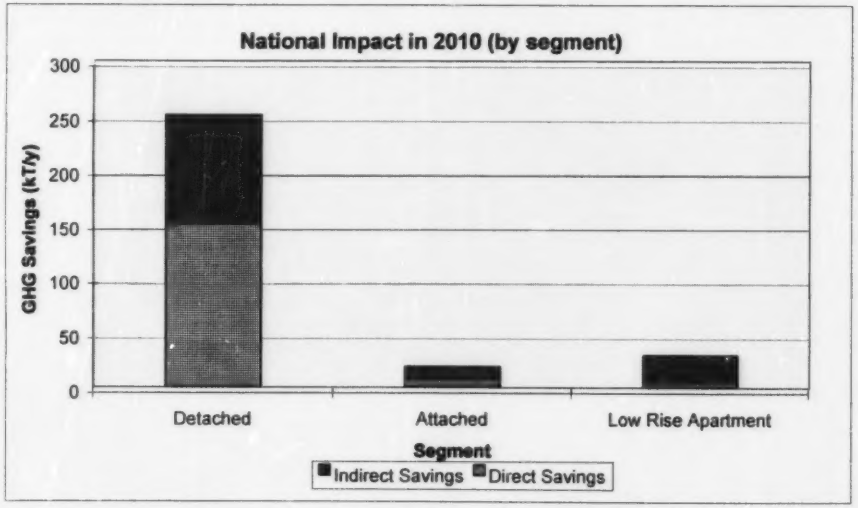
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	7	5	8
Quebec	7	25	18
Ontario	30	15	34
Manitoba	2	2	36
Saskatchewan	3	1	40
Alberta	8	3	57
British Columbia	12	6	26
Total	70	56	

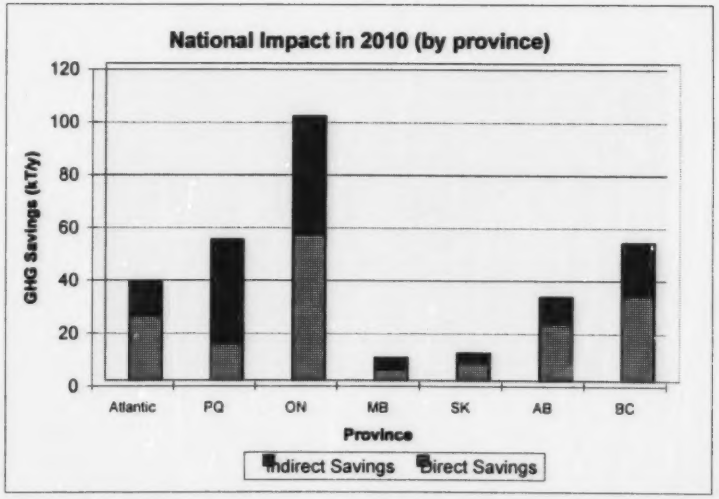
Measure Data Sheet: AE8 - Equipment Leasing Facilitation Program

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
AE1 National Standards for Equipment and Appliances	15%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$363.5
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$289.2
Total GHG reductions in 2010	300 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	12 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$4.8
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$4.8





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Detached	149	101
Attached	8	11
Low Rise Apartment	5	25
Total	163	137

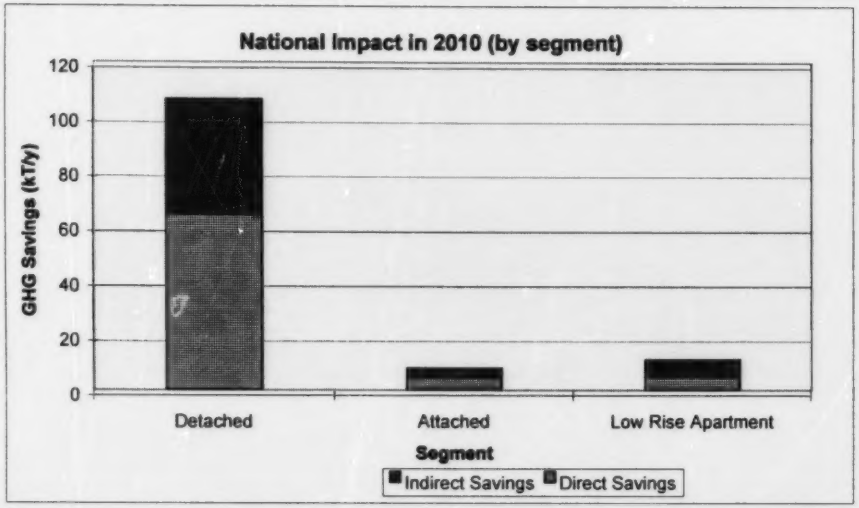
Region	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Atlantic	25	13
Quebec	14	40
Ontario	55	45
Manitoba	4	5
Saskatchewan	7	4
Alberta	21	10
British Columbia	32	20
Total	163	137

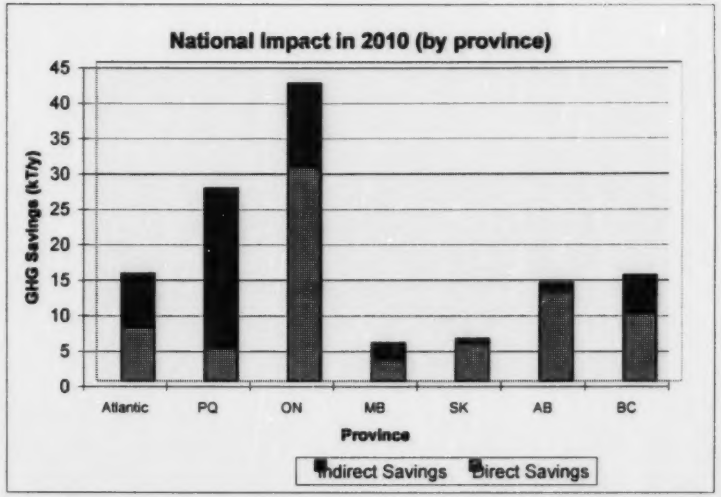
Measure Data Sheet: R10 - Residential Retrofit Guidelines and Installation Standards

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
R3 National Energy Efficient Housing Renovation and Retrofit Program	4%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$209.2
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$113.9
Total GHG reductions in 2010	126 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	38 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$1.0
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$1.0





Segment	**GHG Savings in 2010 Kilotonnes/y eCO_2**	
	Direct	**Indirect**
Detached	64	42
Attached	5	3
Low Rise Apartment	5	6
Total	74	52

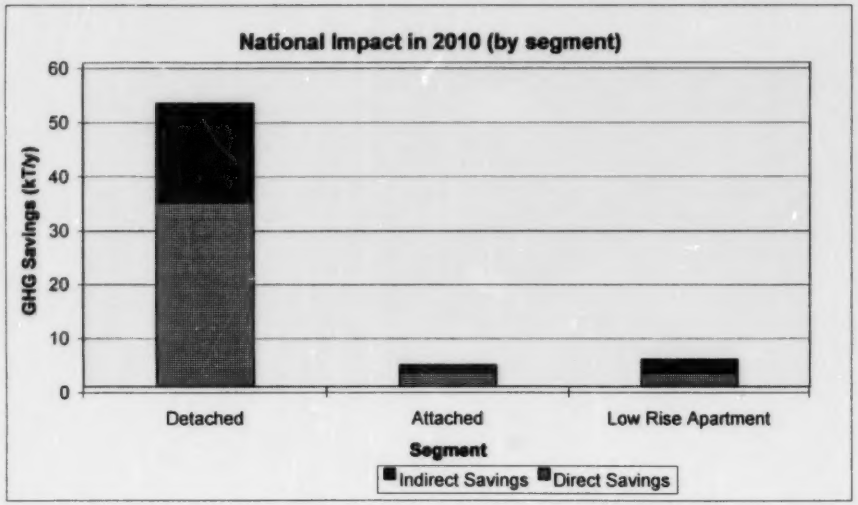
Region	**GHG Savings in 2010 Kilotonnes/y eCO_2**	
	Direct	**Indirect**
Atlantic	8	8
Quebec	5	23
Ontario	30	12
Manitoba	3	2
Saskatchewan	5	1
Alberta	13	1
British Columbia	9	6
Total	74	52

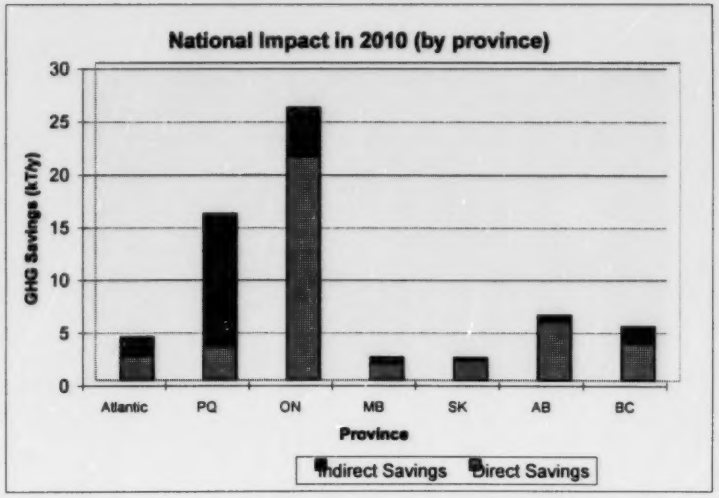
Measure Data Sheet: R11 - Building Permit Feebates

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
R4A Adoption of More Stringent MNECH by Provinces	10%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$65.9
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$48.2
Total GHG reductions in 2010	62 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	14 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	not costed
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$0.0





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Detached	34	18
Attached	3	1
Low Rise Apartment	3	2
Total	39	22

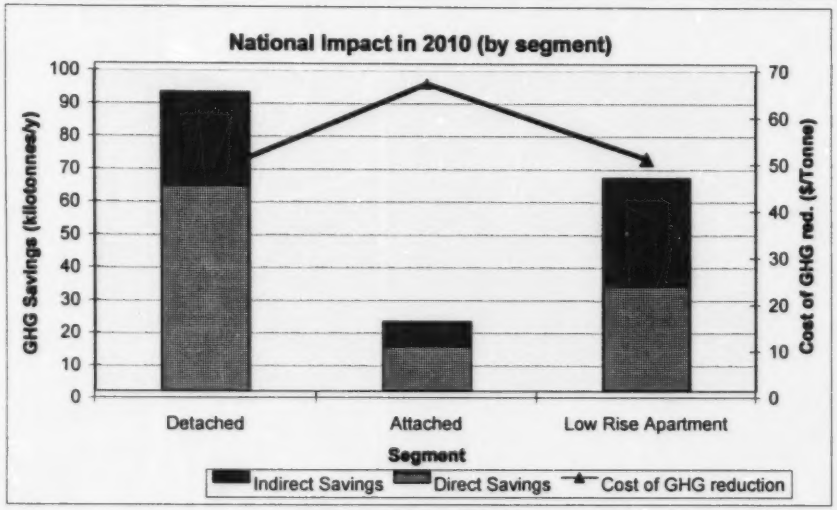
Region	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Atlantic	2	2
Quebec	3	13
Ontario	21	5
Manitoba	2	1
Saskatchewan	2	0
Alberta	6	1
British Columbia	4	2
Total	39	22

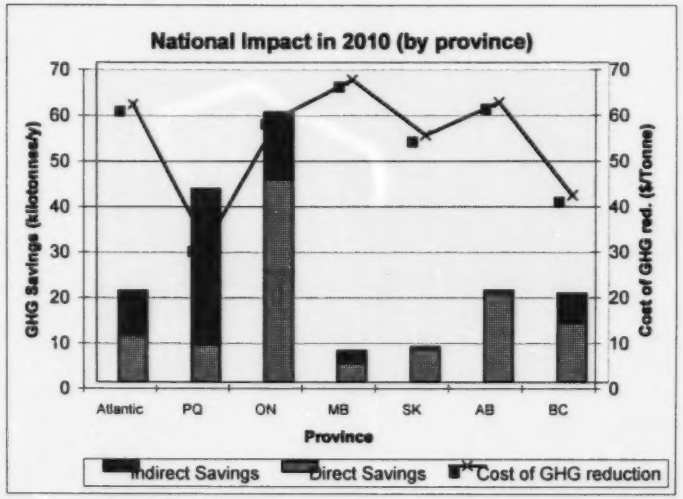
Measure Data Sheet: R-1A - Assisted Housing Program

Summary of Market Penetration			
Actions	**Affected Stock:**	**Market Penetration in Affected Stock**	
		Existing	**New**
E1a,b House As a System Retrofit Bundle	all existing social/assisted dwellings	<33%	
E3a,b, E4a,b High Effic. Furnaces and Boilers	all gas or oil heated existing social/assisted dwellings	26%	
E5a,b, E6a,b Integrated Space Heat & DHW	all gas or oil heated existing social/assisted dwellings	26%	
E11 Improved Furnace Sizing and Installation	all gas or oil heated existing social/assisted dwellings	51%	
E12 Reduced Hot Water Use	all existing social/assisted dwellings	66%	

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$345.6
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$167.8
Total GHG reductions in 2010	178 kT/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	50 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$4.6
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$4.6





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	63	28	46
Attached	14	8	66
Low Rise Apartment	32	33	50
Total	109	69	

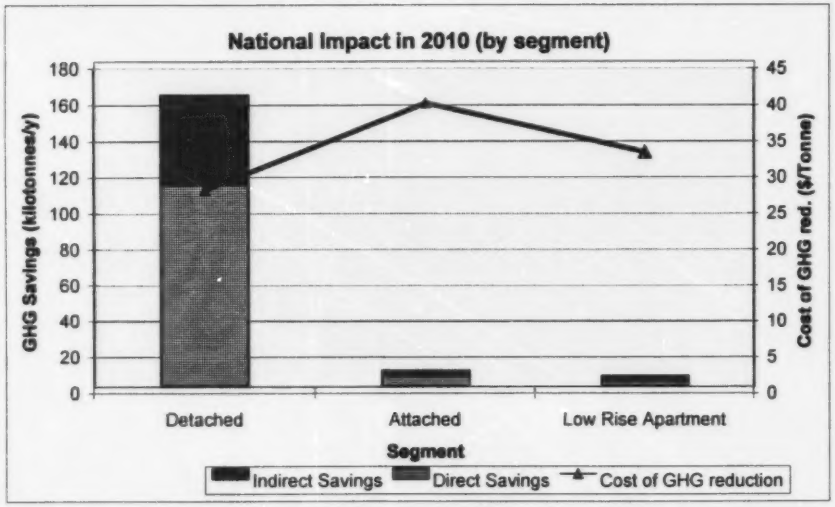
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	10	10	61
Quebec	8	34	30
Ontario	45	15	58
Manitoba	4	3	66
Saskatchewan	7	1	54
Alberta	20	1	61
British Columbia	13	7	41
Total	109	69	

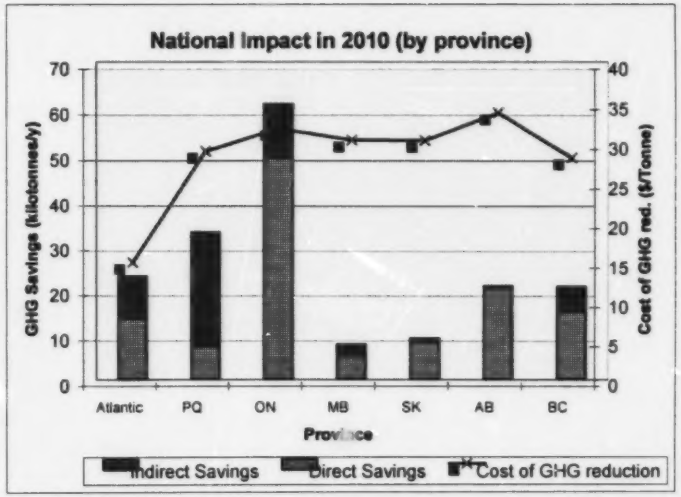
Measure Data Sheet: R-1B - Low Income Housing Program

Summary of Market Penetration			
Actions	**Affected Stock:**	**Market Penetration in Affected Stock**	
		Existing	**New**
E1a House As a System Retrofit Bundle	all existing low income owner-occupied dwellings	<9%	
E3a, E4a High Effic. Furnaces and Boilers	all existing low inc.own.-occ. gas or oil heated dwellings	7%	
E5a, E6a Integrated Space Heat & DHW	all existing low inc.own.-occ. gas or oil heated dwellings	7%	
E11 Improved Furnace Sizing and Installation	all existing low inc.own.-occ. gas or oil heated dwellings	14%	
E12 Reduced Hot Water Use	all existing low income owner-occupied dwellings	22%	

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$259.7
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$160.2
Total GHG reductions in 2010	177 kT/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	28 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$20.8
Cost of incentive, if applicable (net present value)	$51.9
Total cost of program implementation (net present value)	$72.7





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	112	50	27
Attached	6	3	39
Low Rise Apartment	3	3	33
Total	121	56	

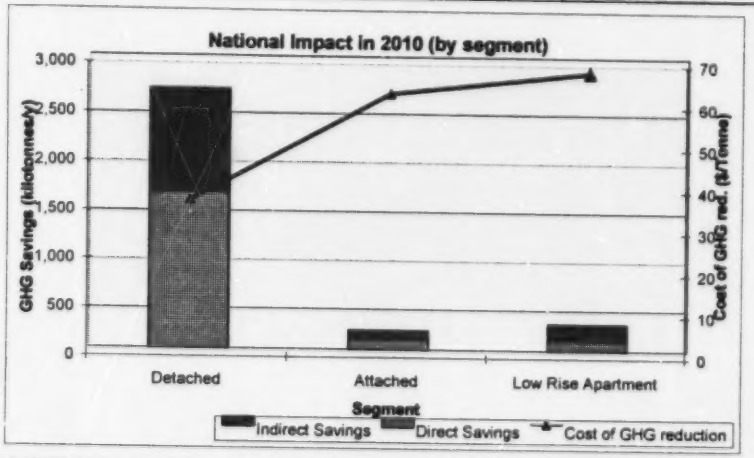
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	13	9	15
Quebec	7	26	29
Ontario	49	12	32
Manitoba	5	3	30
Saskatchewan	9	1	30
Alberta	20	0	34
British Columbia	15	6	28
Total	121	56	

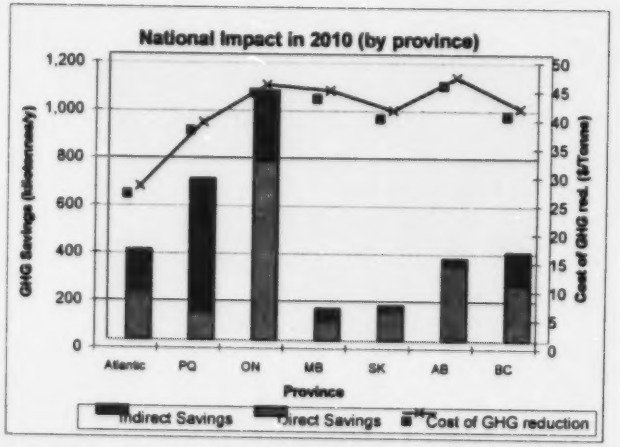
Measure Data Sheet: R3 - National Energy Efficient Housing Renovation and Retrofit Program

Summary of Market Penetration			
Actions	**Affected Stock:**	**Market Penetration in Affected Stock**	
		Existing	**New**
E1a,b House As a System Retrofit Bundle	all existing dwellings	<11%	
E3a,b, E4a,b High Effic. Furnaces and Boilers	all gas or oil heated dwellings	9%	
E5a,b, E6a,b Integrated Space Heat & DHW	all gas or oil heated dwellings	9%	
E7a,b Air Source Heat Pumps	all exisiting electrically heated dwellings w distribution systems	<1%	
E8a,b Ground Source Heat Pumps	all exisiting electrically heated dwellings w distribution systems	<1%	
E9a,b Air Source Heat Pumps & DHW	all exisiting electrically heated dwellings w distribution systems	<1%	
E10a,b Ground Source Heat Pumps & DHW	all exisiting electrically heated dwellings w distribution systems	<1%	
E11 Improved Furnace Sizing and Installation	all existing dwellings	17%	
E12 Reduced Hot Water Use	all existing dwellings	33%	
E13 Improved Appliances, lighting and motors	all existing dwellings	6%	
E14 Solar Water Heaters	all existing dwellings	1%	
E15 Photovoltaic Panels	all existing dwellings	<1%	

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$5,529.2
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$3,010.8
Total GHG reductions in 2010	3,144 kT/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	40 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$1,333.4
Cost of incentive, if applicable (net present value)	$804.9
Total cost of program implementation (net present value)	$2,138.3





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	1,603	1,058	36
Attached	118	86	61
Low Rise Apartment	123	157	66
Total	1,844	1,301	

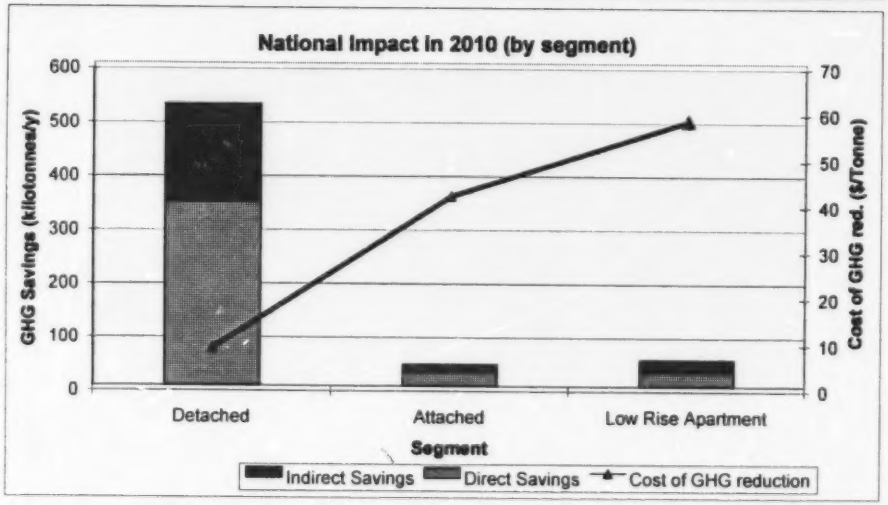
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	191	188	27
Quebec	115	565	38
Ontario	751	299	45
Manitoba	77	58	44
Saskatchewan	130	20	40
Alberta	316	30	46
British Columbia	236	138	41
Total	1,844	1,301	

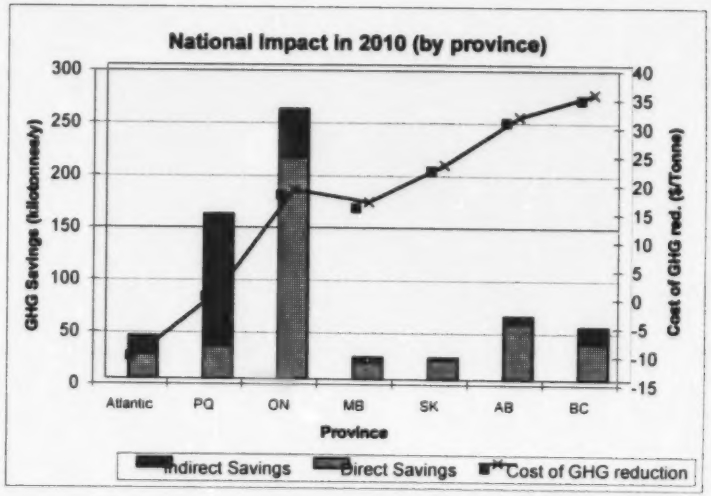
Measure Data Sheet: R-4A - Adoption of More Stringent MNECH by Provinces

Summary of Market Penetration			
Actions	**Affected Stock:**	**Range of Market Penetration**	
		Existing	**New**
N1 Upgraded Model National Energy Code for Houses	all new dwellings	0%	64%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$659.4
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$482.0
Total GHG reductions in 2010	615 kT/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	14 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$6.3
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$6.3





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	342	182	8
Attached	27	13	41
Low Rise Apartment	26	25	58
Total	395	220	

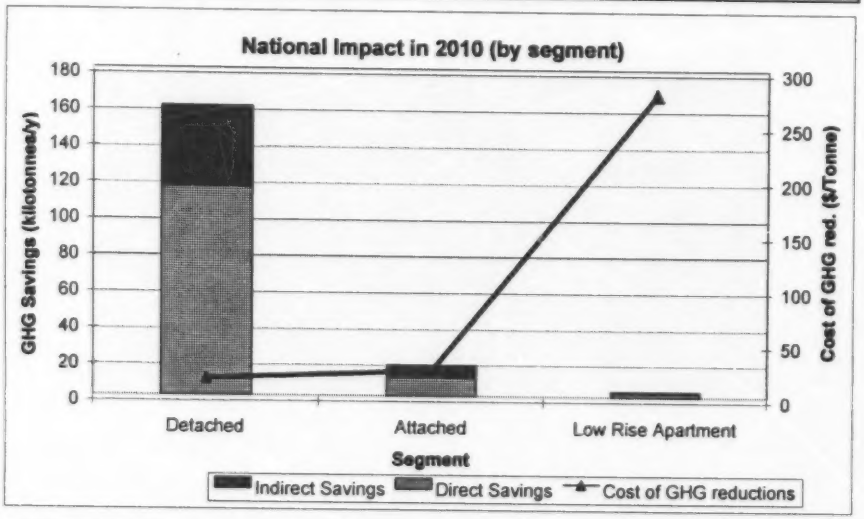
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	23	18	-10
Quebec	32	126	0
Ontario	212	46	18
Manitoba	16	6	16
Saskatchewan	19	2	23
Alberta	55	6	31
British Columbia	35	16	35
Total	395	220	

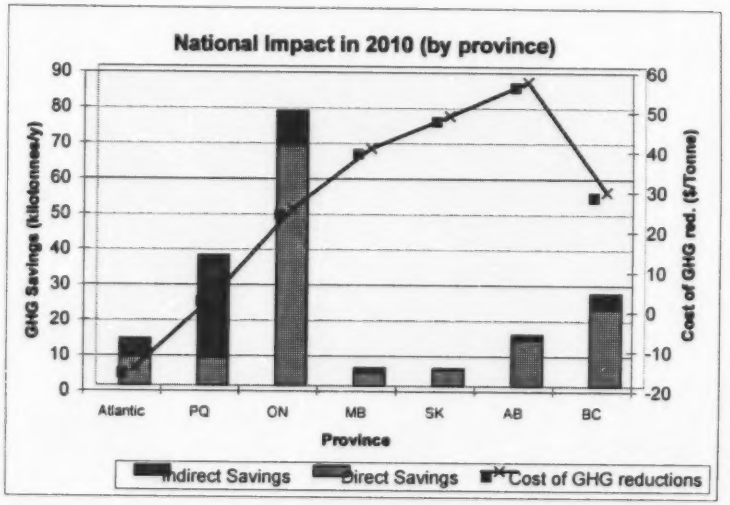
Measure Data Sheet: R-5A - Strengthened R2000 Program

Summary of Market Penetration			
Actions	**Affected Stock:**	**Range of Market Penetration**	
		Existing	**New**
N2 - R2000 Standard	all new houses, apartment buildings <600m2	0%	7.5%/15%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$235.2
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$159.2
Total GHG reductions in 2010	179 kT/y
Cost of GHG reductions stimulated by this Measure - based on above data ($ per tonne/y)	21 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$68.6
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$68.6





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	115	44	16
Attached	11	6	24
Low Rise Apartment	3	0	277
Total	128	51	

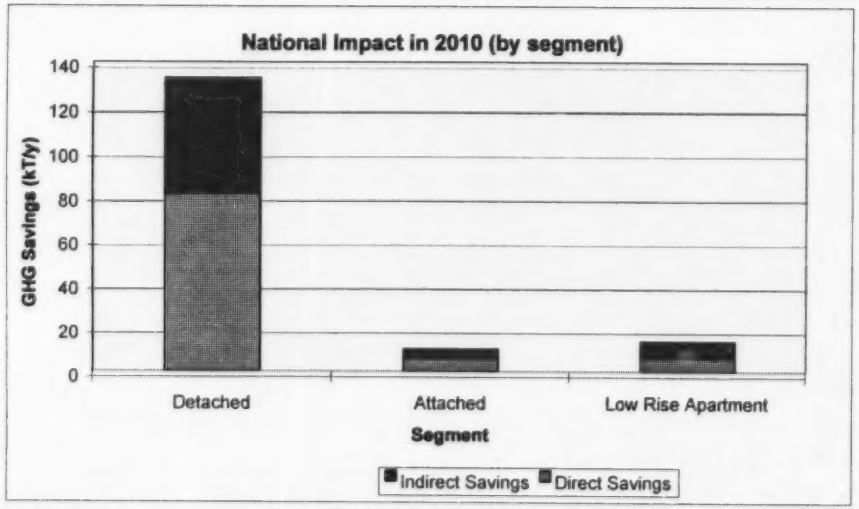
Region	**GHG Savings in 2010 Kilotonnes eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	8	5	-15
Quebec	8	29	3
Ontario	68	10	24
Manitoba	4	1	40
Saskatchewan	5	0	48
Alberta	13	1	56
British Columbia	22	4	29
Total	128	51	

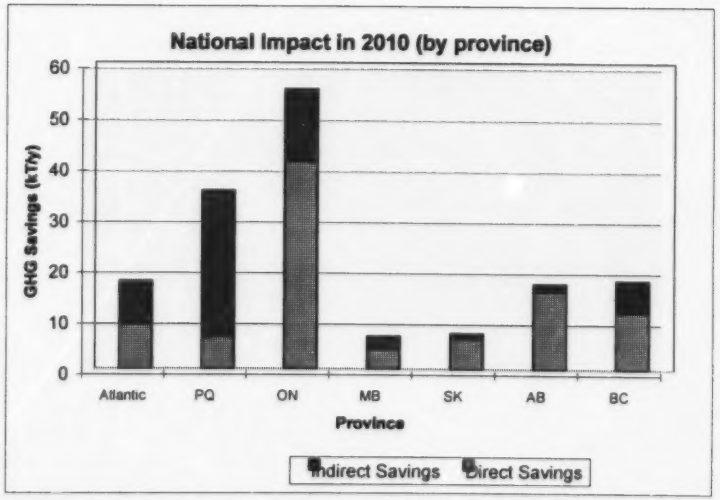
Measure Data Sheet: R6A - Housing Energy Technology Demonstration Program

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
R3 National Energy Efficient Housing Renovation and Retrofit Program	4%
R4A Adoption of More Stringent MNECH by Provinces	5%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$246.0
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$140.8
Total GHG reductions in 2010	157 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	34 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$61.4
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$61.4





Segment	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Detached	81	51
Attached	6	4
Low Rise Apartment	6	7
Total	93	63

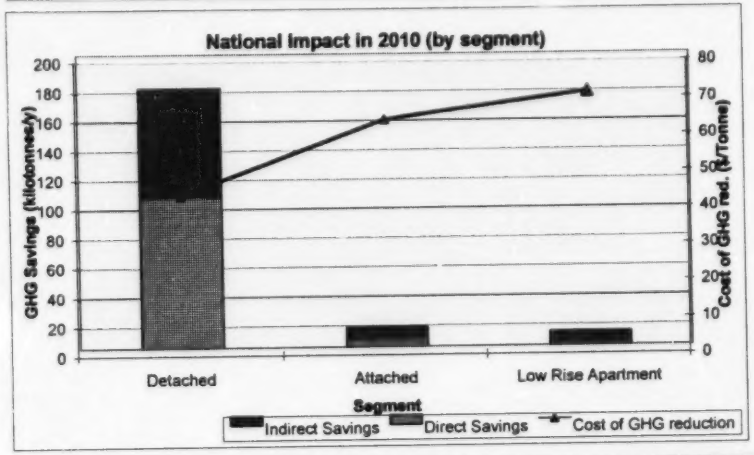
Region	**GHG Savings in 2010 Kilotonnes eCO_2**	
	Direct	**Indirect**
Atlantic	9	8
Quebec	6	29
Ontario	41	14
Manitoba	4	3
Saskatchewan	6	1
Alberta	15	2
British Columbia	11	6
Total	93	63

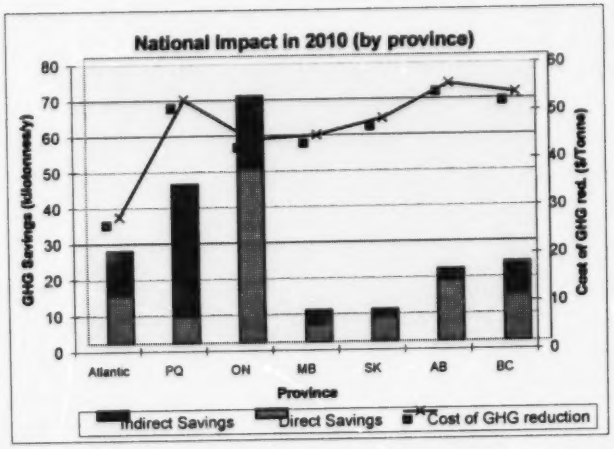
Measure Data Sheet: R6B - R-2000 for Existing Dwellings Renovation Program

Summary of Market Penetration			
Actions	**Affected Stock:**	**Market Penetration in Affected Stock**	
		Existing	**New**
E1c House As a System High level Retrofit Bundle	all existing dwellings	0.7%	
E3a, E4a High Effic. Furnaces & Boilers	all gas or oil heated dwellings	0.4%	
E5a, E6a Integrated Space Heat & DHW	all gas or oil heated dwellings	0.4%	
E7a Air Source Heat Pumps	Existing electrically heated dwellings with distribution	<0.1%	
E8a Ground Source Heat Pumps	Existing electrically heated dwellings with distribution	<0.1%	
E9a Air Source Heat Pumps & DHW	Existing electrically heated dwellings with distribution	<0.1%	
E10a Ground Source Heat Pumps & DHW	Existing electrically heated dwellings with distribution	<0.1%	
E11 Improved Furnace Sizing and Installation	all gas or oil heated dwellings	0.7%	
E12 Reduced Hot Water Use	all existing dwellings	0.7%	
E13 Improved Appliances, lighting and motors	all existing dwellings	0.7%	
E14 Solar Water Heaters	all existing dwellings	0.2%	
E15 Photovoltaic Panels	all existing dwellings	<0.1%	

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$353.9
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$175.9
Total GHG reductions in 2010	201 kT/y
Cost of GHG reductions stimulated by this Measure - based on above da ($/tonne/y)	44 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$92.8
Cost of incentive, if applicable (net present value)	$84.6
Total cost of program implementation (net present value)	$177.4





Segment	**GHG Savings in 2010 Kilotonnes/y eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Detached	103	74	42
Attached	6	7	62
Low Rise Apartment	3	7	70
Total	113	88	

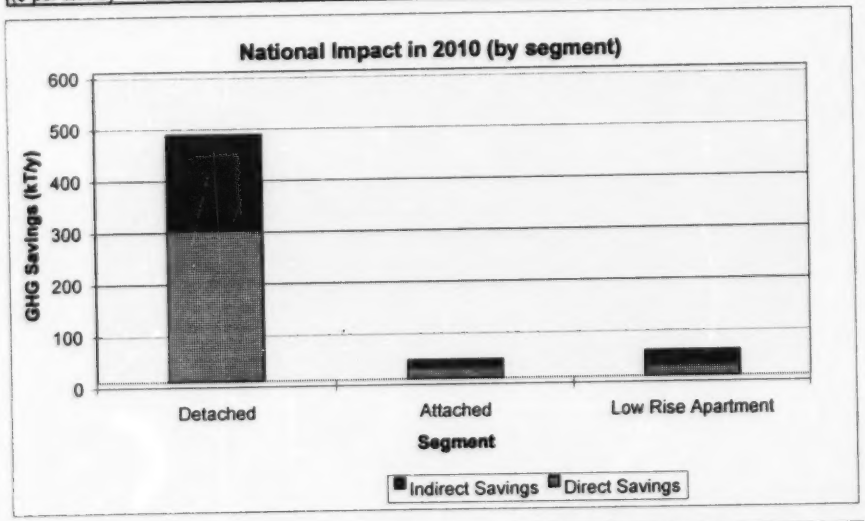
Region	**GHG Savings in 2010 Kilotonnes/y eCO_2**		**Cost of GHG red. $/tonne**
	Direct	**Indirect**	
Atlantic	14	12	26
Quebec	7	37	51
Ontario	48	21	43
Manitoba	5	4	43
Saskatchewan	7	2	47
Alberta	17	3	54
British Columbia	13	9	52
Total	113	88	

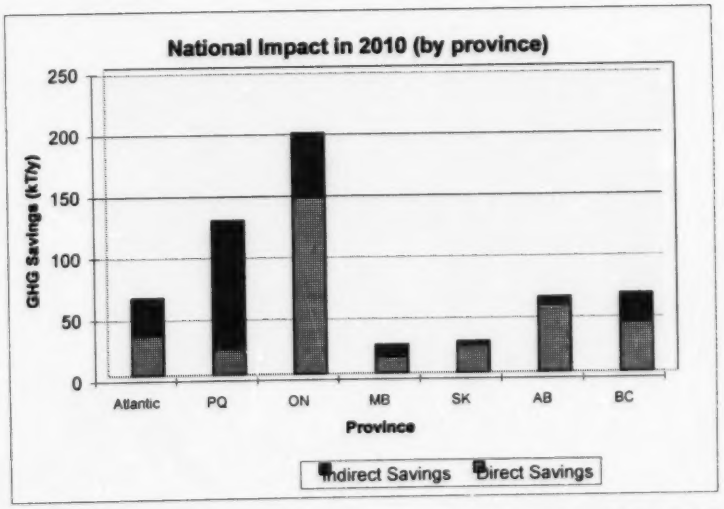
Measure Data Sheet: R-7M - Energuide for Houses - Mandatory

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
R3 National Energy Efficient Housing Renovation and Retrofit Program	15%
R4A Adoption of MNECH by Provinces	15%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$802.7
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$455.5
Total GHG reductions in 2010	564 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	31 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$279.0
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$279.0





Segment	**GHG Savings in 2010 Kilotonnes/y eCO_2**	
	Direct	**Indirect**
Detached	292	186
Attached	22	15
Low Rise Apartment	22	27
Total	336	228

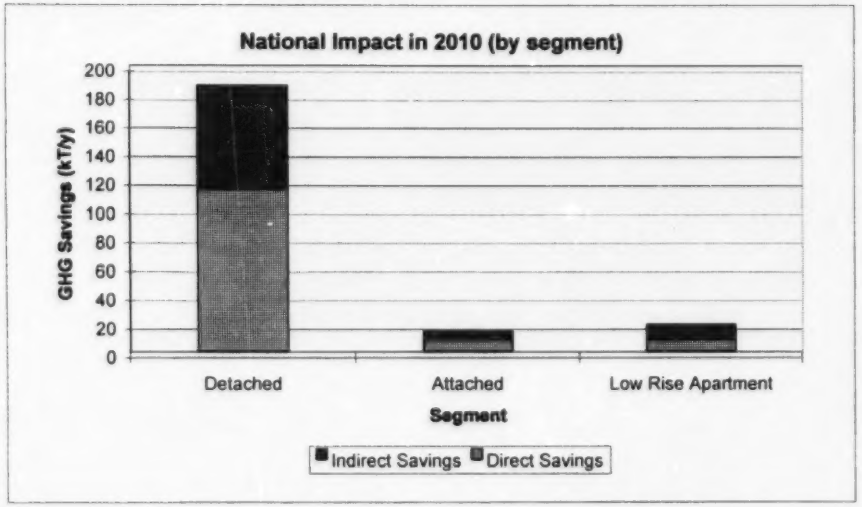
Region	**GHG Savings in 2010 Kilotonnes/y eCO_2**	
	Direct	**Indirect**
Atlantic	32	31
Quebec	22	104
Ontario	144	52
Manitoba	14	10
Saskatchewan	22	3
Alberta	56	5
British Columbia	41	23
Total	336	228

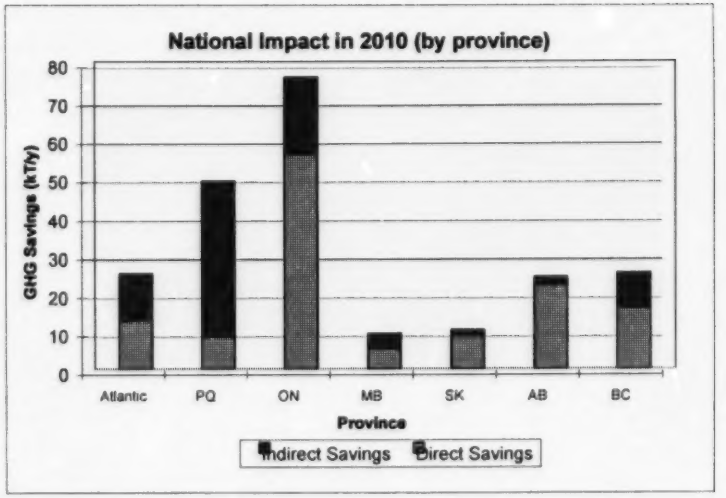
Measure Data Sheet: R-7V - Energuide for Houses - Voluntary

Summary of Affected Measures & Multipliers	
Other Measures Affected by this Measure	**Multiplier**
R3 National Energy Efficient Housing Renovation and Retrofit Program	6%
R4A Adoption of More Stringent MNECH by Provinces	5%

Capital Costs, Energy Savings, and GHG reductions	**(millions)**
Capital Cost of actions stimulated by this Measure, cumulative to 2010 (net present value)	$350.6
Participant energy savings from actions stimulated by this Measure, over the life of the actions (net present value)	$197.8
Total GHG reductions in 2010	219 kt/y
Cost of total GHG reductions stimulated by this Measure ($ per tonne)	35 $/tonne

Costs of Program Implementation (cumulative to 2010)	**(millions)**
Administrative and related costs (net present value)	$46.9
Cost of incentive, if applicable (net present value)	$0.0
Total cost of program implementation (net present value)	$46.9





Segment	**GHG Savings in 2010 Kilotonnes/y eCO_2**	
	Direct	**Indirect**
Detached	113	73
Attached	8	6
Low Rise Apartment	9	11
Total	130	89

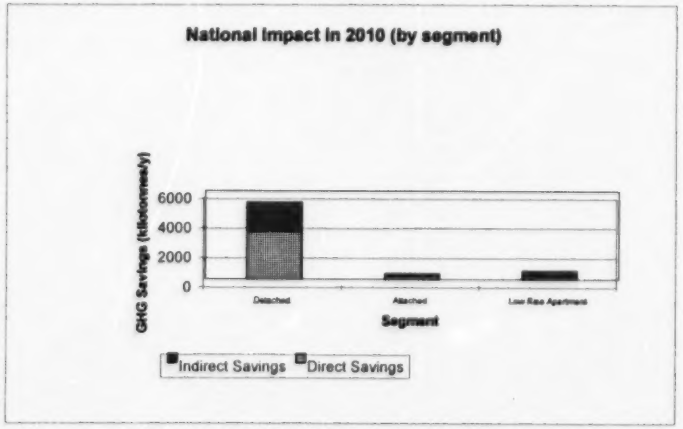
Region	**GHG Savings in 2010 Kilotonnes/y eCO_2**	
	Direct	**Indirect**
Atlantic	13	12
Quebec	8	40
Ontario	56	20
Manitoba	5	4
Saskatchewan	9	1
Alberta	22	2
British Columbia	16	9
Total	130	89

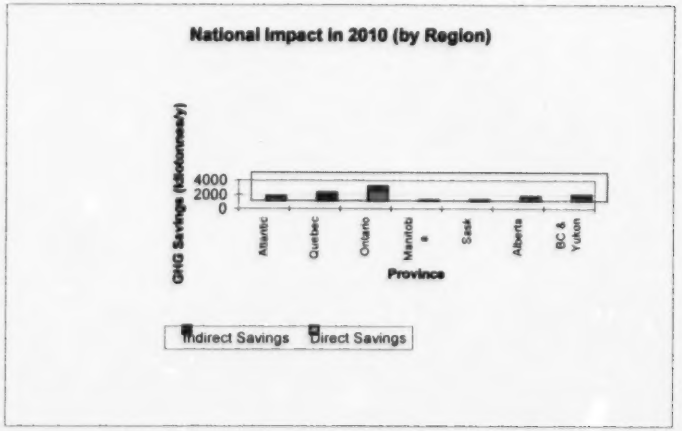
OPTIONS PACKAGE A – LOW-RISE RESIDENTIAL SECTOR

Measures included in Options Package	
Code	**Description**
R-6A	Housing Energy Technology Demonstration Program
AE-8	Equipment Leasing Facilitation Program
R-10	Residential Retrofit Guidelines and Installation Standards
AE-4	Technology Commercialization Program
R-5A	Strengthened R-2000 Program
R-7V	Energuide for Houses Program - Voluntary
AE-5	Premium Energy Performance Labelling Program for Equipment and Appliances
AE-1	National Standards Program for Equipment & Appliances
R-3	National Energy Efficient Housing Renovation and Retrofit Program
R-1B	Low Income Housing Program
R-1A	Assisted Housing Program
R-6B	R-2000 for Existing Dwellings Renovation Program

Capital Costs, Energy Savings, and GHG Reductions	(millions)
Capital cost of Measures cumulative to 2010 (net present value)	$9,262.2
Participant energy savings from Measures, over the life of the actions (net present value)	$5,634.0
Total GHG reductions in 2010	6,281 kT/y
Cost of total GHG reductions for Options Package ($ per tonne)	29 $/tonne

Costs of Program Implementation (cumulative to 2010)	(millions)
Administrative and related costs (net present value)	$1,632.0
Cost of subsidy, if applicable (net present value)	$941.5
Total cost of program implementation (net present value)	$ 2,615.8





Segment	GHG Savings in 2010 Kilotonnes eCO2	
	Direct	Indirect
Detached	3,269	1,983
Attached	224	196
Low Rise Apartment	215	394
Total	3,708	2,573

Region	GHG Savings in 2010 Kilotonnes eCO_2	
	Direct	Indirect
Atlantic	454	323
Quebec	265	997
Ontario	1,457	680
Manitoba	134	102
Saskatchewan	212	49
Alberta	556	106
British Columbia & Yukon	630	315
Total	3,708	2,573

APPENDIX D

- **Members of the Buildings Table**

CLIMATE CHANGE: BUILDINGS TABLE
MEMBERS, OBSERVERS AND ALTERNATES

Members

Christian Fournelle	Association Québecoise pour la maîtrise de l`énergie
Ron Marshall	St. James-Assiniboia School District #2
David Patton	BOMA Ottawa-Carleton
Gilles Rousseau	École de technologie supérieurs, Université du Québec
David McLeod	Green Communities Association
Roger Peters	Saskatchewan Environmental Society
John Butt	Canadian Oil Heat Association
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